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Engineering News-Record

McGraw-Hill Publishing
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d-Area Method
for Columns
ith Eccentric
d Lateral Loads
By E.W. Rettger

Salmon Run
Taken Over
265-ft. Dam

ascule Bridge
with All
Mechanism
Below Deck

AN important industrial enterprise depends upon keeping the Baker River open to the annual salmon run. Though the fish ladder shown herewith appears to be much like other long successfully used ladders, it differs in that each step in the advance upstream is trapped so that fish cannot get back downstream. It therefore permits an unlimited height for fish ladders, whereas in the past about 40 ft. was the limit.

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215

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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

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FRANK C. WIGHT
Editor

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Millions for More Water

AS THESE pages go to press the Board of Water Supply of New York City has just made public the plan to give the city a 434 million gallon per day supply of water to add to the 1,100 m.g.d. supply that the great Croton and Catskill systems combined provide. The details of the plan are outlined on p. 670 of this issue. There is not space here to comment on those details; that will be reserved for a later issue. But it is pertinent to record the wonder that so enormous a project arouses. Years ago Speaker Thomas B. Reed met a criticism of the fact that Congress had just voted a billion dollar appropriation bill with the remark that "this is a billion dollar country." So it is with New York. Four hundred million dollars is a lot of money. It is the largest sum ever proposed for a single engineering project, excepting possibly the as yet remote Lakes-to-Atlantic Canals, and the projected four hundred million subway extension in New York. And it will only just supply the estimated demand at the year of its completion. When six million people elect to live together in one community they have to expect to pay the price that so great an aggregation imposes.

Futile Jaywalking

GENERAL conviction that the jaywalker is a nuisance to traffic officers and vehicular traffic is now crowned by the absurdity that only one of three gains any advantage to himself by being a nuisance. From counts made by the street traffic committee of the Chicago Association of Commerce at many busy street crossings in its home city, it appears that 59 per cent of all pedestrians attempt to cross streets against traffic and that only one-third of these reach the opposite curb any sooner than those who waited for the way to be cleared before starting. Somewhere in the street between lines of moving vehicles two of three dodge and side step until the traffic officer blows his whistle and clears the impeding traffic. And meanwhile vehicular traffic has been retarded and accident has been courted. In arriving at the conclusions that pedestrian as well as vehicular traffic must be controlled the Chicago investigators have come to the attitude of mind to which the directors of traffic in every large city must certainly come. Too many such directors, however, are afraid to attempt to change the habits of sixty per cent of the people of a city. Many cities have done it and are now reaping the benefits of the effort. Absolute prohibition of pedestrian violation of crossing signals is necessary, with immediate arrest of violators. Experience in many cities, notably Los Angeles, has shown that after a preliminary few weeks of resentment the pedestrian himself sees the benefit of control and thereafter operation becomes as automatic as it is for motors. But if the city authorities want to proceed gradually to the needed reform they can watch the coming experiment in Washington, where it is proposed to have a probationary period during which pedestrian traffic violators will be warned and admonished. Thereafter the regulation will be enforced by arrest. Whether the process of reform be quick or gradual it is bound to come if we are to continue to use our streets.

Fish Ladders and High Dams

A FISH ladder has been built at the Baker River dam in Washington which applies a new idea, namely, the very simple scheme of giving salmon a chance to rest during the climb without letting the current carry them downstream. Using this plan, as described elsewhere in this issue, the builders believe that "salmon can be taken over a dam of any height it is practicable to build." This is good news, indeed, because heretofore 49 ft. was believed to be the limit of the salmon's climbing ability and among the fishing interests there was a growing sentiment against high dams. It was feared that fishing interests of the Northwest, powerfully supported, would align themselves solidly against applications for dam permits. The problem, however, was attacked in a constructive way by a joint committee representing both sides of the controversy. To experiments carried on by the Puget Sound Power & Light Co. the department of fisheries of the State of Washington gave its very best talent and the result was success, to the satisfaction of all concerned, in getting salmon over a high dam. The fish are lifted for most of the height, it is true, in an elevator which requires to be power operated during the salmon run, but the run is of short duration and the cost of the elevator, which was chosen as cheaper than a very long ladder, is insignificant. The success of this endeavor is not only a victory for those who tackled the problem: in a territory where salmon run annually in so many streams and where salmon fishing is such an important industry it clears a serious obstacle from the path of future power developments and constitutes a splendid illustration of the progress that comes of co-operation.

Earth Slip Study

LANDSLIDES are an active menace to highways in all the hilly country on both sides of the Ohio River between Ohio and West Virginia. While the mountain states of the Far West furnish examples of larger slides, nowhere are they so frequently and so persistently a hazard and an expense of highway up-keep as in the territory named. And there is little known of their cause or of their likely location, so that builders may safeguard their roads in the original construction. Naturally, the cut for these side-hill roads provokes sliding but slides occur too on the adjacent tilled hillside not gashed by excavation for roadway and ditches.

So far as is apparent, they occur disastrously in one place and not at all in another which to all the senses is exactly similar. It is interesting therefore to note that the highway commissioner of West Virginia has set on foot an investigation to determine when, where, why and how slides occur so that roads may be designed to escape them or at least to minimize their hazard. A geologist and survey parties are in the field. Their findings and conclusions should be interesting and also of value if they tell us what we need to know; which is primarily how to prognosticate occurrence of slides. It is comparatively simple to guard against damage when the point of danger is known.

A Constructive Public Work

A NOTABLE civic development promises to follow the construction in Chicago of the new South Water St., which is this week being opened for traffic. This promise indeed stands out more prominently than does even the service that the new street will render to traffic, though this is of almost incalculable importance. Let us summarize briefly. On the south side of the new street one modern office building is virtually completed, a second is well advanced in construction and others are in the planning stage. Incidentally, the two structures now being built have the innovation of a ground floor—the floor at the lower deck level of the street—garage for parking and caring for cars of tenants. On the north bank where the old railway yards now are, plans are developing for wharves and yard and terminal construction corresponding in character with the new street structures across the river. We may not expect perhaps that all these new works will materialize as quickly as optimistic Chicagoans predict but the fact is certain that they are being actively planned and not merely being dreamed. They are all works which the creators of the physical structures of new South Water St., engineers and constructors, have encouraged and they themselves are essentially engineering works. An accomplishment also in which the engineer designers and constructors of the new street structure can take satisfaction is that the costs have been kept well below the estimates.

Patents on Engineering Designs

PATENTS on novel designs of engineering structures are applied for by two classes of individuals; those that hope to profit thereby and those that desire to protect the idea from commercial exploitation. There might well be a third motive, namely, to patent the results of research so that royalties might supply funds for further research. Progress and development in the arts and sciences sometimes reach a point where a certain improvement or invention is due; that is, as a result of past experience it is almost inevitable that some one will stumble upon the idea that makes possible another important advance. It may be merely accident that determines where this idea is discovered first and it sometimes happens that two or more investigators in different parts of the world hit upon the identical idea at about the same time. Legally, of course, the first applicant for a patent is entitled to any profits that may accrue from an idea. However, in those cases where the patentee is not bent on profit it would be an excellent plan to fix a moderate royalty to be paid to Engineering Foundation or some other similar organization that could be entrusted with administering such funds in the promotion of further research. Royalties for this purpose would be more generally and more cheerfully paid than when demanded by a commercial organization and engineering research would receive much needed financial aid.

A Colonial Problem

ONE of the responsibilities that comes with colonial expansion is uniquely brought to light in a letter just received from Prof. Frank J. Sette, head of the department of civil engineering in the government University of Porto Rico. That little island is expanding rapidly but not rapidly enough to absorb the engineers that the university is turning out. Professor Sette is therefore considering the possibilities of placing these men in the other Spanish speaking Americas. The graduates are trained in engineering under American methods, but they have the advantage over those born in the United States that they speak English and Spanish with equal facility. Such men should have decided possibilities for South and Central American work, which engineers looking for recruits of this type might well capitalize.

Complicating Contract Work

HOW far can an owner go in prescribing the conditions of labor in a construction contract which is let under competitive bidding? That is the broad question raised by the action of the New York Board of Transportation in inserting a "prevailing wage" and an arbitration clause in the new subway contracts. The New York contractors, as noted in our news pages, are fighting these clauses mainly on statutory grounds but the principles involved have wide application to all public works contracts.

A private owner, it is obvious, can set up any labor provisions he chooses; he can, for instance, require that all carpenters shall be blond and over thirty years of age, he can bar union machinists and he can specify a five-day week, but in so doing he himself takes the onus of the extra cost that such provisions may impose and the responsibility for the wide variation in the bidding that will result. A public body, on the other hand, has a responsibility to the people who pay for the work. It is obliged to prepare a contract that will not only lead to the lowest possible cost of the work, but one which will come as near as possible insuring that the bids submitted have a comparable basis of estimate. But the public body has another obligation, a social one. It must maintain conditions of labor on its work at least equal to, and possibly greater than, those prevailing in comparable private work. It would be manifestly scandalous for the state to profit at the expense of the men who do its work.

It is in response to this last obligation that the various "prevailing wage" laws have been written into the statutes. There are lawyers who maintain that they are unconstitutional, and there have been decisions that point that way. But even if a given law is constitutional its application in a specific case must stand or fall upon the practicability of its interpretation. It is in this respect that the "prevailing wage" clause of the subway contract is unjust and impracticable. It cannot be interpreted in fairness to the contractor or with

assurance of economy to the people, who pay for the subways.

Subway work is peculiar to itself. It resembles no other kind of construction that is going on in the New York district. Its labor is not unionized, largely because the existing unions do not cover the classes of labor engaged on the work. There are carpenter unions, but the timbermen of the subways are not carpenters; there are electrician unions, but the kind of men who do the electrical work underground do not necessarily qualify for them; there are, in addition, a number of different trades involved who come under no special class in other work. There is, therefore, no "prevailing wage" for subway workers, that is no real prevailing wage. What would happen if the "prevailing wage" clause were enforced, would be an attempt to impose on the subway contractors a scale of wages for their men equal to those prevalent in trades as nearly comparable as possible, with the result that there would be either constant controversy or else the establishment of wages much higher than those proper for the specialized subway work. In either case the bidder would be faced with the possibility of uncertain but high wage scales and the inevitability of jurisdictional dispute which would follow any attempt to assign the interwoven labor activities of subway construction to specific trades. And the consequence would be higher bids and higher costs to the public.

As to the arbitration clause, its special application in this contract seems an unwarranted extension of a new legal device. Commercial arbitration is being developed as a short cut to settle specific disputes. It is intended to lay down no legal principle, but merely to relieve the courts. Two parties cannot agree on some issue that affects them only, so they agree to submit their differences to the decision of an arbitrator. No outside party can activate any such arbitration, nor has the decision any effect on any one but the parties to the contract. How different is the subway arbitration clause. The contractor, a party in the contract with the Board of Transportation, agrees to prejudice the whole financial outcome of his contract at the instance of a third party entirely outside the contract, that is his own employees, for although the enforced arbitration can come only from the contractor or the Board, it is obvious that the latter, a political body, will be only too willing to lend a friendly ear to the claims of labor and only too glad to shift the responsibility of decision onto an arbitration board. And the decisions of such a board have significance far beyond the case decided, for there are many similar contracts, and every contractor is in the end bound to be subject to the arbitration wage decisions on any other contract. Enforced arbitration would make for uncertainty as to bidding bound to be reflected in higher costs.

Both clauses, therefore, seem to be against public policy. It is not so much that they are unfair to the contractor, though that is enough to weigh against them, as that they will cause endless confusion and additional cost. Further than that, they seriously affect the nearly $100,000,000 worth of subway contracts already let, in that if carried out on the new, and undoubtedly higher cost, contracts they will completely disorganize labor conditions on those sections now under way. The present contractors should have a good case for damages against the contract making body that so seriously alters its form of contract in the middle of a great work.

The proposed clauses have been inserted by the New York Board of Transportation, it is claimed, to reduce the number of labor disputes which it has had to settle. That this number is large is denied by the contractors, who intimate, on the contrary, that the board is led by a desire to placate the union interests in the city. Whatever the cause, it is evident that the means taken are indefensible, both in the specific case and as a guide to similar practice. If the urge of competition and the ordinary process of law cannot insure a proper labor reward on public work, that is a reward considered proper by the contract letting body, it might be possible for that body to write an entirely new form of contract in which it took the responsibility for the labor scale.

Let it, for instance, set a base rate for all classes of labor before the contract is let. Let all bidders bid upon that basis, and then if during the life of the contract the rate has to be changed let that change be made by the owner, or in the case of public work, the proper body, and let that body assume as loss or gain the difference that results. Then each contractor could bid on a known base of wage and would rely for preference on his own skill, that is his ability to produce with the unit of labor. That would take another element of gambling out of contracting, and would make the public officers directly responsible for the increased costs of labor instead of concealing such increases in the bids, where they can be blamed on the contractor and on the contract system of construction.

Thin-Brick Pavements

ALMOST a score of years ago paving engineers in Southwestern cities began to lay down streets of wire-cut, vertical fiber, lugless brick of 2½ and 3 in. thickness instead of the 4-in. standard. These streets appeared to stand up in service and the construction was continued. It was regarded at first as an aberration of practice and indeed continued to be so regarded until, within a few years, competitive paving costs turned attention to ways and means of cheapening first costs of brick paving. Then the possibilities of the off-standard construction began to be studied. The latest of these studies, the brick pavement tests and field survey of the Bureau of Public Roads, is reported in this issue.

These tests head up the dispute over strength to the conclusion that the thinner brick, 2½-in. brick, are amply strong for much road service, but they do not altogether settle the integral problem of brick pavement economics. There is a reduction in material costs by using thin brick and there is some slight gain perhaps in speed of laying the lighter brick, but generally construction labor processes and plant will not be sensibly decreased. A total saving of from 10 to 40c. per sq.yd. is claimed for the thin brick. Against such a saving must be set the claims that the thick brick has a larger wear factor of safety, has a greater salvage for turning and relaying and finally that, with modern increasingly heavy street traffic loads, it is necessary to work toward greater pavement thickness instead of toward thinner pavements. The test findings prove that for much paving 2½ and 3-in. brick have an unquestionable place in the street and highway engineer's design practice. That they are in all respects the equivalent of the 4-in. standard brick is not demonstrated.

Annual Salmon Run Taken Over 265-ft. Baker River Dam

Plan of Trapping Fish Ladder Against Downstream Travel Makes Climbing Record—Elevators Used for Most of the Lift—Design Follows Meeting of Joint Power and Fisheries Committee

A HEIGHT of 49 ft. has long been accepted in the Northwest as the limit beyond which salmon would not climb up a fish ladder on their way to spawning grounds. With dams of a greater height proposed for several streams in that territory frequented by salmon a decided conflict of interests arose between power companies and the fishing industry. However, experiments at the Baker River dam in Washington where the scheme of trapping each step in a fish ladder against the return of the fish downstream have met with complete success and the prompt and complete movement of this season's salmon run over the Baker River dam is reported to be accepted by the Washington State Department of Fisheries as indicating the unqualified success of this means of getting fish over high dams. There is, therefore, prospect that the objections of the fish industry to high dams can be entirely overcome.

Although an elevator is used at the Baker River dam to lift the fish the major portion of the height, the latter was put in as a matter of economy in saving the cost of an excessively long fish ladder, and does not affect the assertion, based on the result of these experiments, that "fish ladders can be built that will be used by salmon in going over a dam of any height it is practicable to build."

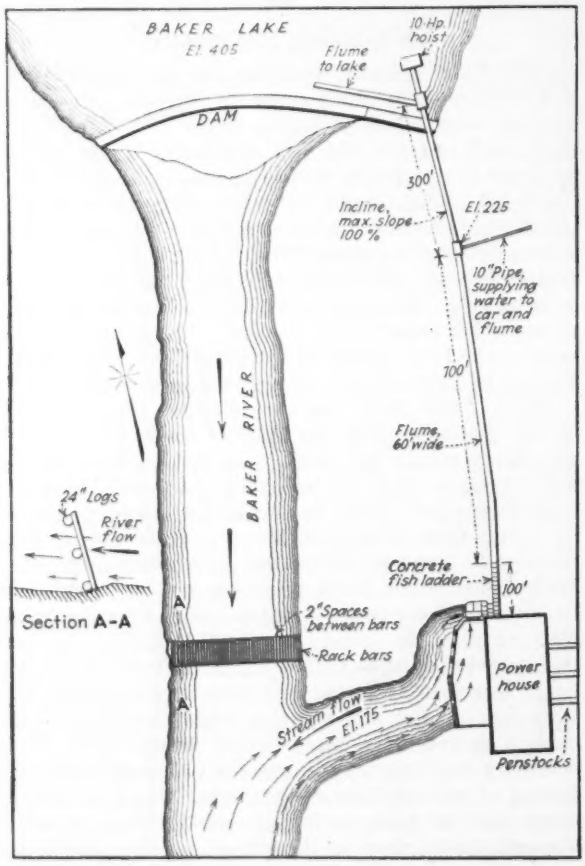


FIG. 1—LOCATION OF BAKER RIVER FISH LADDER AND INCLINE

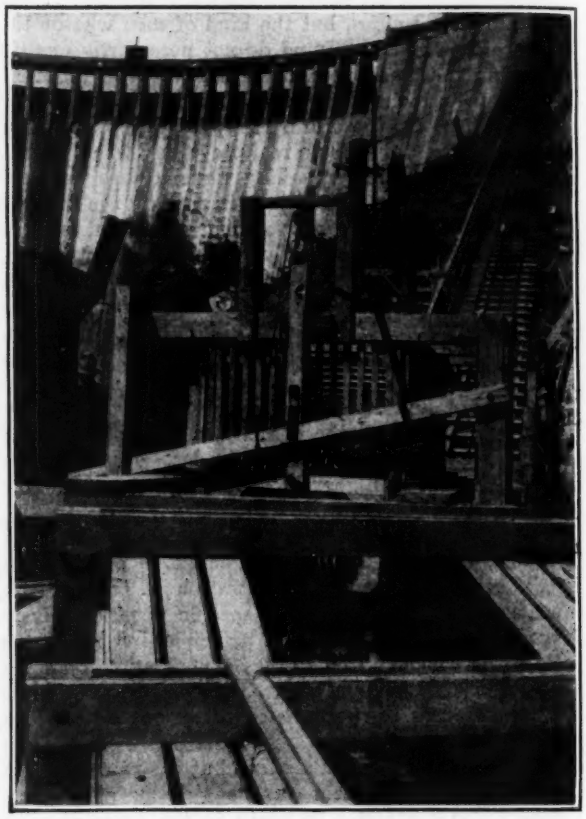


FIG. 2—STEEL CAR ON INCLINE AT THE TOP OF LADDER

All salmon caught in Puget Sound of the variety known as Sockeye, which is regarded as superior for canning purposes, are hatched in Baker Lake whence they migrate to sea after attaining a year's growth, returning to spawn as the "salmon run" of the fourth year thereafter. Hence an important industrial enterprise depended upon keeping Baker River open to the annual salmon run.

Two years ago fishery interests, alive to the menace to their industry attending the construction of high dams on rivers used by the fish as spawning grounds, drew attention to the fact that three high dams were proposed in Washington alone, each of which it was feared would affect the fishing industry disastrously on the stream involved. These projects are at Kettle Falls in eastern Washington, Priest Rapids on the Columbia River and the Baker River dam. A joint fisheries and power company committee was then formed to seek some solution of the problem acceptable to both interests. From this committee have come suggestions and ideas which have been the foundation for the successful fish ladder now in operation at the Baker River dam.

The fish ladder at this dam, built after two years of experimental work, is much like the ladders that have long been used successfully on other streams except that each step in the advance upstream is trapped so that the fish cannot get back downstream. The theory is that when the fish gets tired or discouraged it will not be carried dowstream by the current but is trapped at the point where it happens to be until it is ready to proceed.

The most important element in the scheme is the curved finger-like rods which are placed in each 2-ft. drop of the ladder and constitute a guard or trap. These rods do not constitute a barrier to movements upstream because the salmon invariably leap over such waterfalls. But the salmon never leaps in his travel downstream, he merely allows the current to carry him back. This sort of downstream travel is not possible with these traps and hence a tired fish that would otherwise be carried down by the current is kept in the pool by these rods.

To take advantage of the topography near the dam the first stages of the Baker River fish ladder were built close to the power house. Next there is about 700 ft. of flume ending in a final 2-ft. overpour at the foot of an inclined track. Here the pool above the last rise consists of a steel box on wheels that can be hoisted up the incline when a load of fish has entered it. This box has a cover that serves as a baffle to prevent the fish from overjumping while it is open and which is closed during the railway trip to prevent fish from leaping out. At the top of the incline the car delivers into a hopper whence the fish slide down a wooden chute into the lake back of the dam. Once in the lake above the dam the fish promptly find their way to the hatchery at the upper end of the lake where they are taken care of during the spawning season so effectively that only about 10 per cent of the eggs fail to develop into the "small fry" stage.

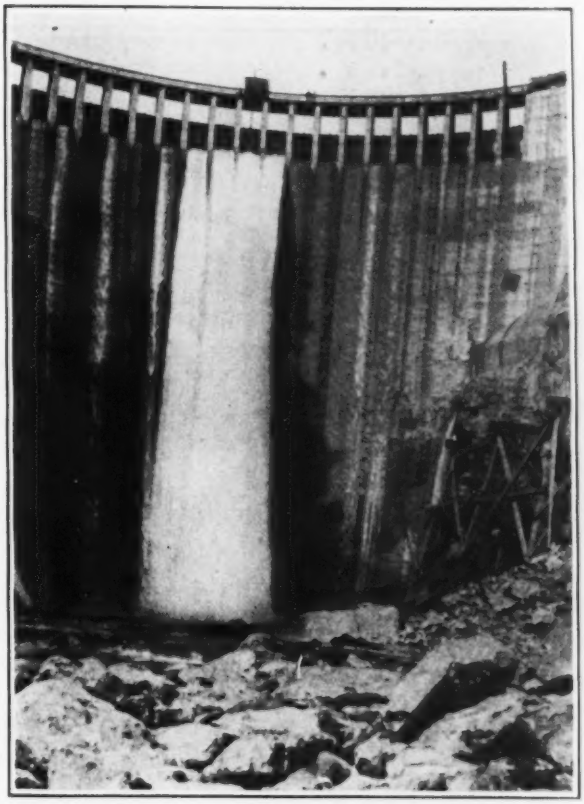


FIG. 4—THE 200-FT DROP THE YOUNG FISH MAKE

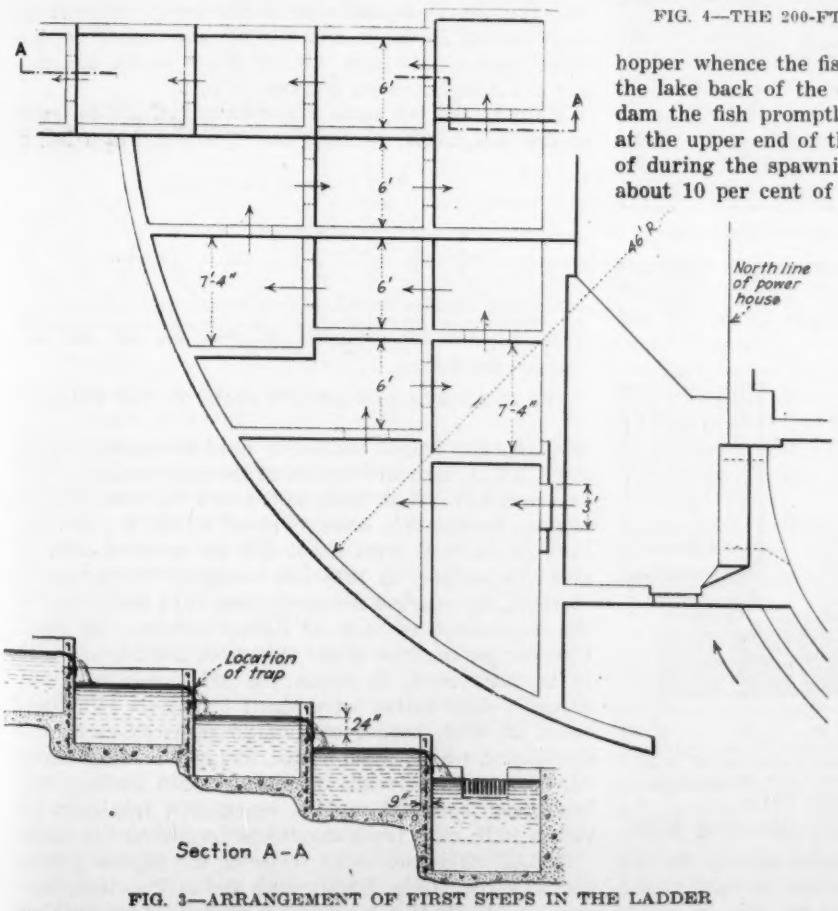


FIG. 3—ARRANGEMENT OF FIRST STEPS IN THE LADDER

At the outset some question was raised as to whether the young migratory salmon, one year old and 6 to 7 in. long, could successfully go down over a dam with an overpour drop as high as 200 ft. The fact that the small fish successfully make this drop has been demonstrated by experience this year. The report of the state supervisor of fisheries who observed the young fish passing downstream at the power house states that "they are still in schools, active, handle themselves well in the swift current and from all appearances are no worse off as a result of their trip over the dam."

When these young salmon start downstream they move in large schools, schools estimated to contain 10,000 fish having gone over the dam in

FIG. 5—SALMON JUMPING UP THE 2-FT. STEPS

an hour. At these times it is customary to open two of the central gates on the dam, an amount sufficient to make this the main overpour sought by the fish and

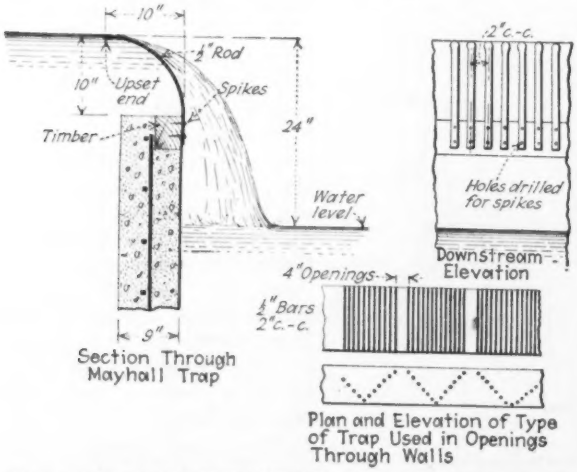


FIG. 6—DETAILS OF TRAPS OF WALL AND WEIR TYPE

then to open one gate slightly at either side of the two central sections. This plan provides a thin water cushion over the concrete surface of the dam on either side of the main overpour and any fish falling on either side of the main stream do not strike the concrete directly.

Credit for much of the development work done in

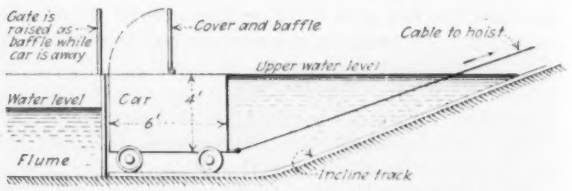


FIG. 7—CAR AT FOOT OF INCLINE

making the Baker River ladder a success is attributed to L. E. Mayhall, state superintendent of hatcheries. W. D. Shannon, general superintendent, Stone & Webster, Inc., Seattle, Wash., represented the power companies on the joint committee and had direct charge of the work at Baker River.

Rail Failures and Axle Loads on the P. & L. E. R.R.

High Stiff Rails Show Advantages in Wear and Joint Efficiency—Relation of Engine and Car Loads to Failures

A PRACTICAL illustration of the relation of rail section to rail failure and of the rapid increase in rail failures to be expected under heavy increase of concentrated loads is afforded by experience on the Pittsburgh & Lake Erie R.R., as shown on the interesting and comprehensive diagram, Fig. 2.

Main tracks for some years have had 100-lb. rails of the A.R.A. (B) section, now obsolete, which has a

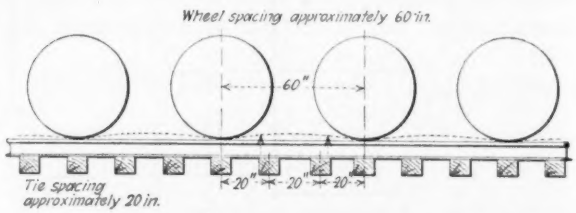


FIG. 1—RELATION OF ENGINE LOADS TO THE TRACK

relatively low height and heavy head as compared with the A.R.E.A. standard section of the same weight which superseded it. With these rails and 2-8-0 consolidation engines having axle loads of about 42,500 lb., the rail failures declined from about 220 per year in 1910 to about 70 per year in 1918 (on a total of 70,000 tons in service), the marked decrease since 1914 being due to the elimination of rails of lighter section. In 1916, however, locomotives of the Mikado or 2-8-2 type began to be introduced, in which the axle loads with the assumed distribution were about 62,500 lb. Furthermore, in 1917, hopper cars of 70 tons capacity were introduced, which, when loaded, had axle loads of about 51,000 lb. As a result of this increased loading, rail breakages increased rapidly, reaching a maximum of 990 in 1921, with track conditions remaining the same.

In 1921, this road began replacing the shallow 100-lb. rail with the 115-lb. Dudley high and stiff section, having a relatively thin head which receives more working

in the rolls than a thick head does. In fact, the 115-lb. rail with only 15 per cent greater weight had 50 per cent greater stiffness than the old 100-lb. rail. Failures of all rails promptly dropped to about 450 in 1922, but increased again in 1923, owing to the increased number of heavy locomotives and particularly to the great increase in heavy freight cars.

From the second peak of 860 in 1923 there was a steady fall to 460 in 1925, with prospect of continued decrease. At the same time, the tonnage of 100-lb. rails in main track is decreasing steadily, as shown by the diagram, and probably these rails will be entirely superseded by the 115-lb. rails in 1927. Failures of the latter rails have been very few, reaching a maximum of two in 1924, shown at the bottom of the chart.

As to the relation of axle loads to rail failures, it is evident that while the failures were being reduced under the original loading they increased enormously

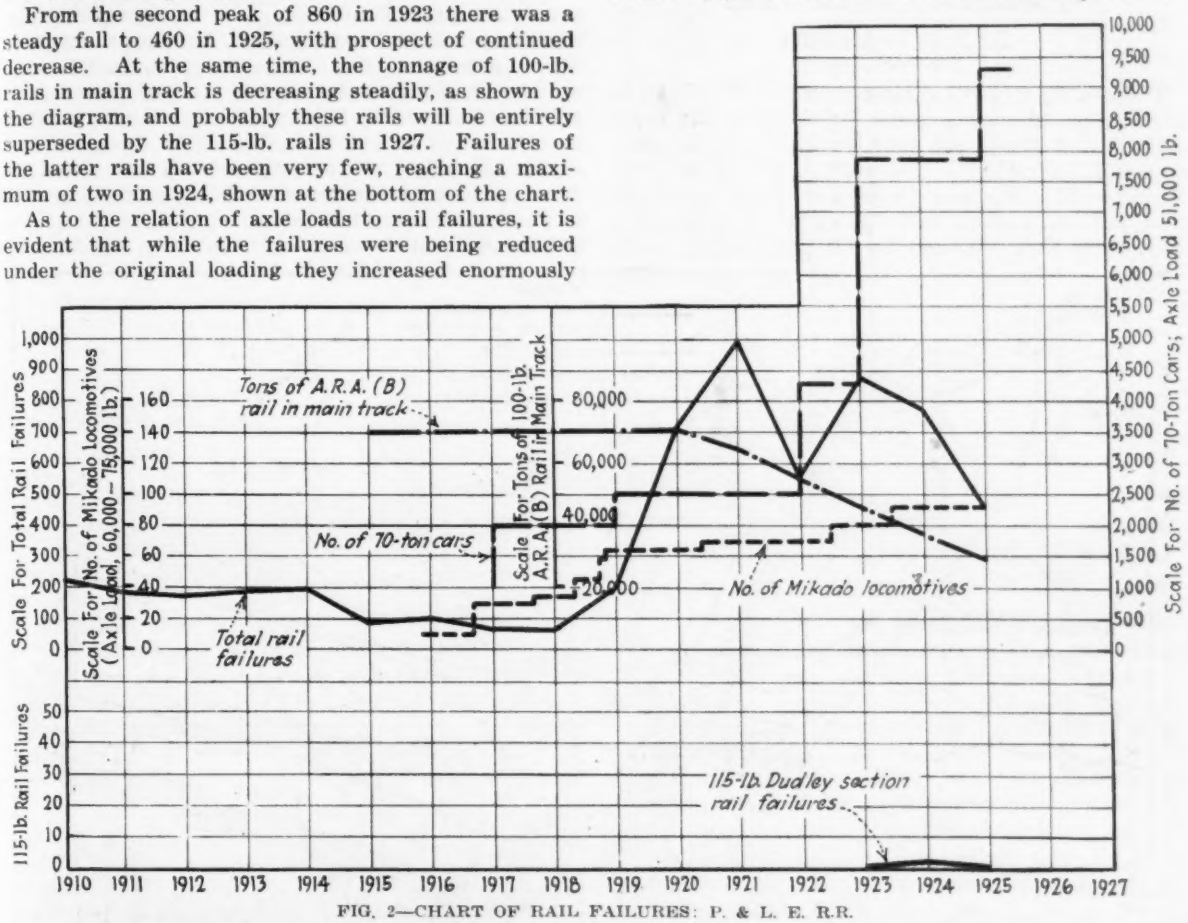

Scale For Total Rail Failures
Scale For No. of Mikado Locomotives (Axle Load, 60,000—75,000 lb.)
Scale For Tons of 100-lb. A.R.A.(B) Rail in Main Track
Scale For No. of 70-Ton Cars; Axle Load 51,000 lb.
115-lb. Rail Failures
Tons of A.R.A. (B) rail in main track
No. of 70-ton cars
No. of Mikado locomotives
Total rail failures
115-lb. Dudley section rail failures
1910 1911 1912 1913 1914 1915 1916 1917 1918 1919 1920 1921 1922 1923 1924 1925 1926 1927

FIG. 2—CHART OF RAIL FAILURES: P. & L. E. R.R.

under the new and heavier loading. This result indicates that the latter loads exceeded the economic relation between the loads and the 100-lb. rails. As soon as there was an appreciable amount of the stiffer rail in use, this relation was restored, but was exceeded again for awhile owing to the increase in number of high loads as compared with the increased mileage of 115-lb. rails.

A study of the track structure under loads would indicate in general that the maximum loads from locomotive axles are applied at points about 60 in. apart, more or less, and that the tie spacing in general is about 20 in., as shown in Fig. 1. The rail so loaded is practically like a continuous beam under stress and the loading can be understood by inverting the plan and considering it in the light of the locomotive axles being the supporting piers or posts and the tie reactions being the loading. This will show clearly the continuous girder effect, as indicated by the dotted line. Considered in this manner, the splices of the 100-lb. A.R.A. rail of B type had a depth in relation to the 60-in. span of approximately a ratio of 1 to 24, indicating great flexibility. The splice bars were apparently designed for strength without proper regard to stiffness.

As a result, this flexibility was shown by horizontal shear between the bars and the rail head and base so great as to cause motion by the passage of each wheel. This motion caused abrasion to the extent that in two or three years the bars and rail heads and bases were worn sufficiently to allow the splice bars to come in contact with the webs of the rails and to require continual tightening of the splice-bar nuts. The splice bars in question, of heat-treated steel, were 26 in. long, with four holes spaced 7-4-7 in. The 38-in. heat-treated splice bars with $\frac{7}{8}$-in. bolts used without spring washers or nut locks and supported on three ties are satisfactorily supporting the joints in the 115-lb. Dudley section rail.

The chart, showing graphically the relation between track and traffic conditions, was prepared by A. R. Raymer, chief engineer, Pittsburgh & Lake Erie R.R.

Missouri Gasoline Taxes Show Increase

A total of $3,946,710.06 in gasoline taxes had been collected and paid into the Missouri State Treasury and credited to the good roads fund up to Sept. 1, covering the first eight months of this year. This represents the payment of the 2c. tax on 188,601,900 gal., although some companies are still to report on gasoline sales made during July and August. It is anticipated the collections for the entire year will total $6,000,000 and that the gasoline consumption will exceed 300,000,000 gal. Last year 259,163,000 gal. paid $5,021,562 into the treasury.

Hydraulic Giants Place Slag Fill From Railway Cars

Three Nozzles Empty Fifty-Ton Car and Distribute Slag to Grade in Five Minutes—Thaw House Enables Work in Winter

By Reed D. Achauer
Ambridge, Pa.

A 60-ACRE fill 20 ft. deep forms a unique hydraulicking operation now under way between the Pennsylvania R.R. tracks and the Ohio River some 14 miles west of Pittsburgh, Pa. The work is being done by the Duquesne Slag Products Co. as a combined waste disposal and land grading operation on the property of the Kenilworth Land Co., and the fill is granulated blast-furnace slag. This is brought in by railway in hopper-bottom cars and high-pressure water jets are being used to empty the cars and to carry and spread the slag up to 200 ft. from the service tracks which traverse the area being graded. It is the arrangement and operation of the jets which are the unusual features.

Development of Filling Plan—The original topography and the area as graded are shown by Fig. 1. The railway was the obvious means of slag delivery. It was the proximity of the river which suggested the hydraulic method of placing the fill, there being ample water, no very great gravity head and a maximum pipe line length of perhaps 1,700 ft. So with the area of fill delineated as shown on Fig. 1, the main delivery track system and the pipe line system were laid out. They are indicated on Fig. 1 and were installed ahead of the fill. Procedure then in developing the filling plan was (1) Diking the areas to be filled, (2) installing pumps and pipe lines and (3) grading the delivery tracks.

The first step before filling was to throw up dikes around the edge of the tract. For the most part these dikes were earthen embankments, built by a dragline. However, in some places where it was difficult to construct such embankments use was made of a temporary bulkhead as shown by Fig. 2. The bottom was boarded up to a height of several feet, and ½-in. mesh, extending to the height of the proposed fill, was placed in front of these boards, the whole being properly braced and supported every few feet.

The next, and the most important, step was to provide water for the operation. A pump boat with two 10-in. centrifugal pumps, driven by 200-hp. electric motors, was anchored close to the scene of operations. Each of these pumps was capable of independent action, it depending on the amount of water required whether both were used or not. Power lines extended overland to the edge of the river and out to the boat. The intake was suspended on a pontoon, so that the pipe would automatically be under water with the rise and fall of the river. The intake passed to the pump boat, and from there to the shore connection of the main feed water pipe line, to which it was attached by means of a rubber gasket, thus giving the system freedom to rise or fall with the river.

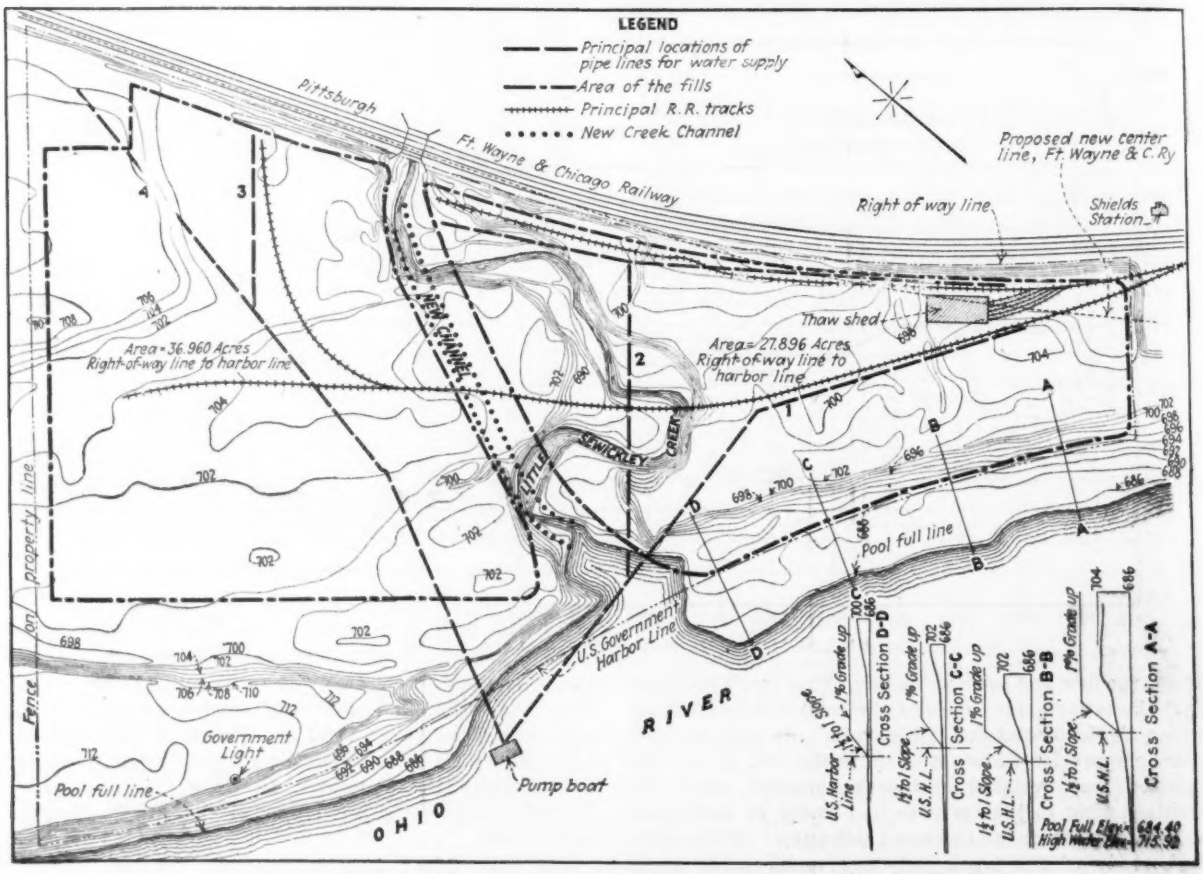


FIG. 1—DELIVERY TRACK AND PIPE-LINE LAY-OUT FOR MAKING SLAG FILL

The main feed water line was constructed of 15-in. light-gage sheet-steel pipe. This line was laid out over the tract in the most advantageous positions with reference to the shifting of the railroad tracks and also so that every part of the tract was within reach. It was laid at an elevation above that of the fill, being carried on an improvised trestle of light timber framework where the fill was deep. Where the fill was shallow it was propped up to the required height by light timbers spaced 15 or 20 ft. apart.

Railroad embankments to the level of the proposed fill, were built over the tract in advantageous positions from which to do the filling. There was of course a shifting of the track, or a sequence of taking up and laying down track as the fill progressed. New lines were laid when the fill widened from 200 to 350 ft. The original railway embankments started from the edge of the Pennsylvania R.R. fill already in place. The filling for the new locations was done by sluicing. The final leveling for tracks (2 to 4 ft.) was done by dragline or by dumping and tamping up.

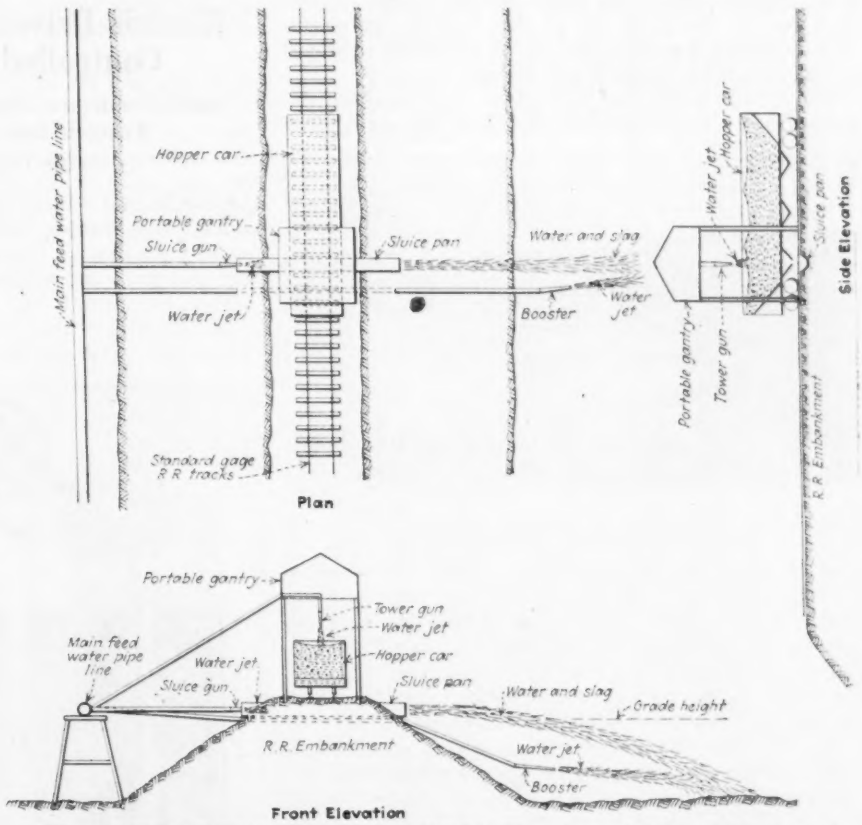


FIG. 3—NOZZLE ARRANGEMENT FOR UNLOADING CARS AND SPREADING SLAG

Hydraulicking Methods and Plant—The outfit for placing fill is shown by Fig. 3. Portable gantries were

FIG. 2—WIRE MESH BULKHEAD HOLDS EDGE OF FILL

set up over the tracks and as the fill at one point was completed they were moved along the tracks completing the fill at each point before they were moved to another position.

Four such gantries were in operation, and as the procedure at each was the same, the method employed will be outlined for one only. The embankment directly under the gantry was hollowed out sufficiently to admit a semi-circular trough, or sluice pan. This sluice pan, 30 in. deep and about 15 or 20 ft. long, was made of ¼-in. sheet steel. It was inserted through the opening in the embankment normal to the tracks, with its top flush with the bottom of the ties. The main feed water line running along the tracks was tapped and a smaller lateral with a long nozzle on its end was brought up to one end of the sluice pan. When both pumps at the pump boat were working, a pressure of 120 lb. could be maintained at the nozzle. This long nozzle arrangement, called a sluice gun, was applied at one end of the sluice pan, thus shooting a jet of water through the trough.

A hopper car filled with blast furnace slag was brought up in position underneath the gantry, so that its hoppers when opened, discharged into the sluice pan. Then from the top of the gantry another nozzle arrangement, this being called a tower gun, and operating under the same pressure head as the sluice gun, was turned into the hopper car so as to discharge the contents of the car into the sluice pan. The water from the sluice gun shooting through the trough caught up this slag and washed it out onto the tract that was being filled. Close to the end of the sluice pan was another hydraulic gun, this being called a booster. It picked up the slag that the sluice gun had carried out, and boosted it out over the area.

The booster was a tapering pipe about 8 ft. long with a nozzle diameter of 2 to 4 in. It was operated by an apparatus of home-made wood construction. The back end of the booster was mounted on a swiveling arm, while to the front end was fastened the front end of a wooden bow-spring, formed by lapping half a dozen planks together endwise. This spring ran lengthwise along the top of the booster extending about

6 ft. beyond and 15 in. above the back end. A man standing at the back end of this wooden bow-spring and operating it could swing or tilt the booster through any horizontal or vertical arc desired.

With both pumps at the pump boat working the booster had a nozzle pressure of 120 lb. and could throw

FIG. 4—BOOSTER NOZZLE WITH WOOD BOW-SPRING TILLER

a jet of water nearly 400 ft., maintaining an effective velocity head for a distance of 200 ft. Most of the time, however, the booster was operated under a nozzle pressure of 90 lb. and the spreading range of the jets was from 25 to 60 ft. with effect decreasing with distance. If the fill was quite a distance away from the gantry, the sluice pan was run out close to the spot by adding more sections of trough, end to end. Additional boosters put along the line boost the slag out.

The minimum rate at which a hopper car averaging 50 tons of slag, could be emptied and boosted out to the fill, was one every five minutes. The work was carried on at night as well as day, and searchlights were operated from the top of the gantries.

The grading operations described have been carried out for the last several years, working in winter as well as summer. In the winter months, it was quite often necessary to thaw out the slag before the cars could be emptied, and for this purpose, the hopper cars full of slag were run through a thaw house. The thaw house contained four tracks, each capable of holding six cars. The thawing was done by heat from steam lines on the ground between the tracks. Occasionally, however, the slag was thawed out by turning a steam jet through a nozzle directly onto the slag.

Panama Canal Traffic, Fiscal Year 1926

Twenty-four nations were represented in the traffic through the Panama Canal during the year ended June 30, 1926. Three—Ecuador, Honduras and Portugal—were represented in 1926 for the first time in several years, while Argentina, Ireland and Nicaragua were not represented, though they had ships through the canal during the fiscal year 1925. Vessels of United States registry led, with 2,432 transits, tolls of $11,539,809.38, and 13,710,956 tons of cargo. These comprised 50.7 per cent of the aggregate net tonnage, paid 50.3 per cent of the total tolls, and carried 52.7 per cent of the total cargo tonnage. Ships of British registry were second, with 1,423 transits, $6,569,712.05 in tolls, and 6,750,843 tons of cargo. Norwegian ships were third with 306 transits, $875,812.99 in tolls, and 1,051,276 tons of cargo. German ships were fourth, with 163 transits, $658,858.12 tolls and 885,007 tons cargo.

Electric-Driven and Automatically Controlled Sewage-Works

Small Pumps and Sprinkling Filter Distributors Thrown Into and Out of Service with Variations in Flow

AUTOMATICALLY controlled electric power is used at the Wandle Valley sewage-works, England, to operate the sewage pumps, the air compressors for lifting and pressing sludge, the valves for turning tank effluent on and off the sprinkling filters, and for the rope-driven sprinklers that travel back and forth over the filters. The electric control devices vary the number and total capacity of the pumps in service according to changes in flow and also regulate the distribution of sewage on the filters both as to the rate and the time interval of the dose.

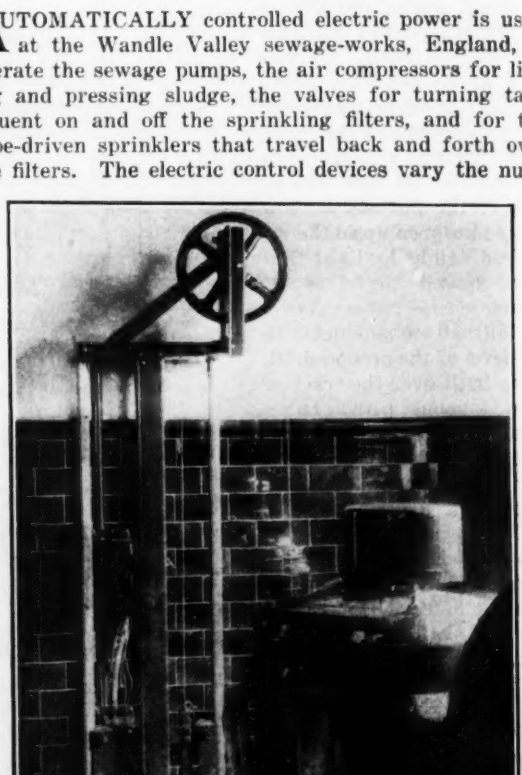


FIG. 2—TAPPET FLOAT GEAR CONTROLLING TWO SEWAGE PUMPS AND TWO SEWAGE DISTRIBUTORS

The works under consideration were recently completed by the Wandle Valley Joint Sewerage Board to serve Mitcham, where the works are located, and several other places, with a total estimated population of about 64,000 in 1920. The new works, which supersede old ones, are designed for a population of 96,000, on the very low dry-weather basis, compared with American practice, of 25 Imp. g.d. (30 U. S. gal.), which gives a total capacity of 2.4 m.g.d. or 2.88 U. S. m.g.d. In accordance with long-standing government regulations, the plant is able to treat three times this amount to the full extent in times of storm, while special tanks are provided for the storm-water flow between three and six times the dry-weather flow.

After storms these storm-water storage tanks may be emptied by pumping their contents to the regular settling tanks.

The new works include five pumps for low- and three for high-level sewage with combined horsepowers of 48 and 90 respectively; two electric-driven air compressors working at 80 lb.; settling tanks with a total capacity of 2 Imp. m.g. or 2.4 U. S. m.g.; primary humus tanks with a total capacity of 0.2 Imp. m.g. or 0.24 U. S. m.g. in six 20 x 20 x 20-ft. compartments; six sprinkling filters 91 ft. wide and 502 ft. long, with a clinker depth averaging 6 ft.; two secondary humus tanks; and six sludge presses.

The foregoing information is based largely on an article in the London *Surveyor* for Nov. 6, 1925. What follows, including the two views, comes from our London correspondent:

Fig. 2 shows the main switchboard, which comprises control for the five pump motors, three 12-hp. and two 6-hp., for the high-level sewage, interlocks between those and the distributor motors, and pilot lamp indicators to show how many and which of the six distributors are at work at any time, as well as switches and fuses to control a feeder to the storm-water pump.

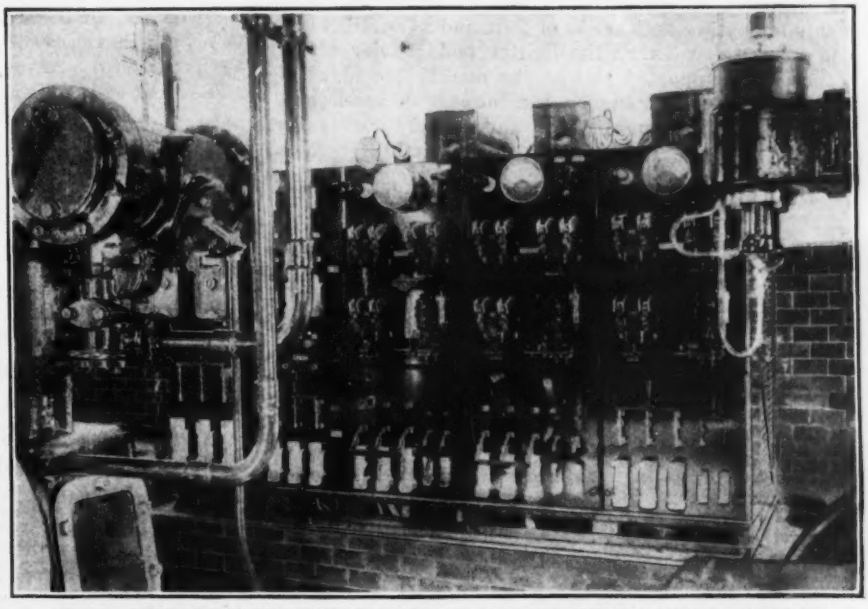


FIG. 2—SWITCHBOARD CONTROLLING FIVE PUMPS AND SIX DISTRIBUTORS

On the extreme left of the switchboard (not shown in the photograph) is a five-tappet float gear controlled by the movement of a float in the sewage well. This is the master device that controls all operations of the pumps and distributors and its effects are as follows: As the sewage in the well and the float rise the latter turns the five tappets in succession with the following results: The first tappet starts No. 1 6-hp. pump and No. 1 distributor; the second tappet starts No. 2 6-hp. pump and No. 2 distributor; the third tappet starts No. 1 12-hp. pump and No. 3 distributor and stops No. 1 6-hp. pump; the fourth tappet starts No. 2 12-hp. pump and No. 4 distributor and stops No. 2 6-hp. pump; the fifth tappet starts No. 3 12-hp. pump.

Thus it will be seen that when very little sewage is entering the station as little as 6 hp. is consumed, and this is increased by steps of 6 hp. each as the flow of sewage increases until the maximum of 36 hp. is in use. As the quantity of incoming sewage decreases, the float falls and reverses the tappets in succession, thereby causing the motors to be stopped in reverse order from that of starting. As the pump which is started first is the last to be stopped it is necessary periodically to change the order of rotation so that each pump and motor may be subjected to approximately equal wear. This can be done weekly by changing the relative positions of the five plugs in the five sockets on the second panel of the switchboard.

In the low-level pump house are three 30-hp. electrically driven pumps and two 28-hp. electrically-driven air compressors. Fig. 1 shows a two tappet float gear similar to that in the high-level pump house, except that it has two tappets only to control two 30-hp. motors and the two distributors which are interlocked with them. The third 30-hp. pump and motor are spare and when needed are started by hand.

The automatic starters for the compressor motors operate in the same manner as the pump starters, but instead of being controlled by floats they are operated by pressure regulators. Each of these is adjusted to start its motor when the pressure is as low as 65 lb. and stop it when the pressure has been pumped up to 70 lb. In order that the compressors may always start light, solenoid-operated unloading valves are fitted alongside the pressure regulators, which connect the compressor outlet to the unloader during starting.

In order that a distributor shall not stop at any intermediate position between the beginning and end of its journey, a limit switch is arranged to short out the float-switch contacts except at the point where all the water valves are closed. In the case of the high-level pumps the pump runs on after the opening of its float switch till the corresponding distributor has reached the end, but, owing to the small size of the low-level tank, the low-level pump is arranged to stop as soon as its float switch opens, while the distributors carry on to the end position.

The power for the scheme is 205 volts, 2-phase, 3-wire, 50 cycles, and the entire plant can be controlled by one man. Willcox & Raikes of Birmingham are engineers to the plant, and the electric control was devised and installed by the Igranic Electric Co., Ltd.

New Road Service Montevideo to Buenos Aires

It is proposed to construct a new automobile road between Montevideo and the free port of Colonia, the nearest city on the Uruguayan shore to Buenos Aires, according to advices from the American Minister at Montevideo to the U. S. Department of Commerce. The journey from Montevideo to Buenos Aires could be made in approximately 6 hours by the new road, a shortening of 3 hours from the fastest steamer time.

Tests Show 2½-in. Brick Will Carry Heavy Traffic

Bureau of Public Roads Reports Thin Brick Pavement Amply Strong—Field Survey of Pavements Confirms Test Results

THE U. S. Bureau of Public Roads has just released a report on its investigations of thin-brick pavements indicating that bricks of 2-in. and 2½-in. thickness will respectively carry the lighter and heavier traffic, if properly supported and of the quality tested. The investigation was made by the bureau as accelerated traffic tests at Arlington, Va., and as field surveys or studies in Texas, Louisiana, Oklahoma and Nebraska. The analysis of the data obtained, the report states, seems to warrant important conclusions, among which are:

(1) That 2½-in. brick of the quality used in the Arlington traffic tests, when properly supported, will prove satisfactory for pavements carrying the heavier types of traffic.

(2) That brick of 2-in. thickness, when properly supported and of the quality used in the tests, will be adequate for pavements on streets carrying the lighter types of traffic.

(3) That a bedding course of plain sand is more effective in reducing breakage of brick than a cement-sand bedding course, the breakage being much less on the former than the latter. The depth of the sand-bedding course should not greatly exceed ¾ in. Increasing the depth tends to produce roughness in the pavement.

(4) That cobbling of the brick is greatly increased as the spacing between bricks is increased.

(5) That the use of excessive quantities of asphalt filler is a common and serious fault in construction, unnecessarily increasing the cost and resulting in a condition which impairs both the appearance and the serviceability of the pavement.

(6) That any base construction of other than the rigid type may in many cases prove entirely satisfactory. Macadam bases and those constructed of certain types of natural earth appear to be suitable when the local conditions are such that these types of construction maintain their stability throughout the year.

(7) That no difference in the base construction is necessary for the different thicknesses of brick.

The accelerated traffic tests have been carried on during the last several months. Their object was to obtain data on the relative resistance to heavy-truck traffic of paving brick of the several thicknesses, and every effort was therefore made to eliminate all other variable factors which might influence the results of the tests, the only exception being the use of the two kinds of bedding course. Because of the opportunity afforded by the test to study the relative merits of the plain sand and cement-sand bedding, it was decided to include this feature, and accordingly the pavement as laid includes duplicate sections of each thickness of brick, one on each of the two types of bedding.

In order to minimize the possibility of a variation in the quality of brick used, they were all obtained from one manufacturer, and all are of the vertical-fiber, plain wire-cut, lugless type, 8½ in. long and 4 in. wide, the depths for the sections being 2, 2½, 3, 3½, and 4 in.

Regarding the production of thin brick the report states that the manufacture of brick as thin as 2½ in. is accomplished without difficulty. Some loss from warping was said to have occurred when brick of this thickness was first manufactured. Later changes in the manufacturing process, particularly in the burning, have made this loss negligible at the present time. The brick manufacturers in the section of the country where the thinner brick are being used, were found to be favorable to the manufacture of the 2½-in. type. The manufacture of brick with 2-in. thickness was believed by some to be impracticable because of the loss occurring from warping during burning.

Reduction in the cost of a brick pavement built of thin brick is the result of decreased cost of such items as manufacture, transportation, handling on the job, and saving in the filler material.

Based on the cost of a 3-in. pavement the saving in materials and costs for each ½-in. reduction in thickness would be approximately:

Item	Per Cent
Manufacture	10
Freight	16
Haulage	16
Filler	16

Article in Iron Age - dJan 12

Development of Arc Welding of Steel Structures

Some Items of History Since 1920—Impact Strength of Welded Joints—Possibilities in Design

BY A. M. CANDY
General Engineer, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

IN 1920 several steel industrial buildings of arc-welded construction were erected in England and in the United States, probably the first commercial structures of the type. Since that time, extensive progress has been made in applying welding to structural steel work, and much greater progress is in sight.

At Tottenham, England, a completely welded building 70x200 ft., one story high, was built. The structure had hollow block walls, steel columns and steel roof trusses (Fig. 2), the latter arranged in a middle bay of 40-ft. span and two 15-ft. lean-to bays. The columns were made of H-sections with cap and base plates welded to their ends. The trustees were made up almost wholly without gusset plates, the tension member usually being passed between the two elements of the compression members.

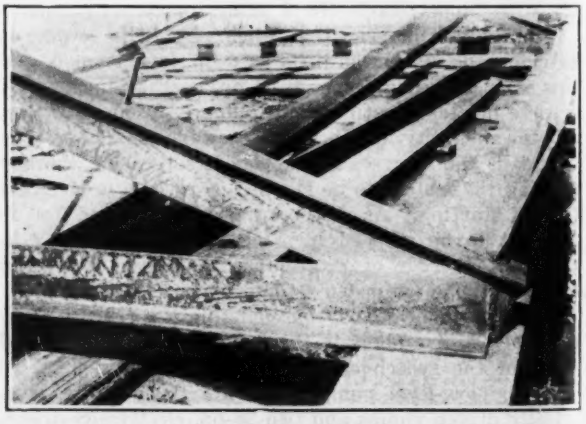


FIG. 1—HEEL JOINT OF TRUSS IN A BROOKLYN WELDED BUILDING

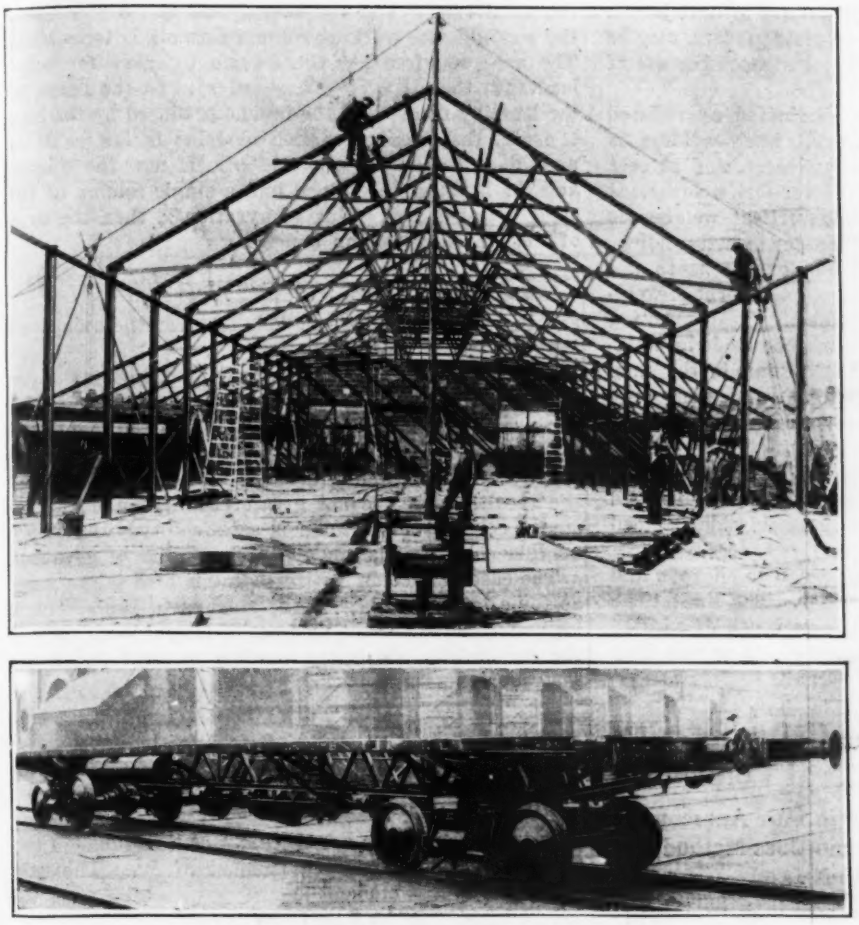


FIG. 2—TWO EARLY WELDED STRUCTURES
Building at Tottenham, England, and underframe of Australian railway car.

Two other English structures built during the same year were a one-story sawtooth roof building of 22,000 sq.ft. area, and a building for the Olympia Horse Show, of 9,000 sq.ft. area. In a third, a foundry addition 54x100 ft., a 20-ton crane runway was provided, the crane brackets as well as all the other structural connections being welded.

In the United States, a small mill building 40x60 ft. was erected in Brooklyn (detail of heel joint in Fig. 1). Brackets for a 5-ton crane runway were welded to the columns. It was reported that the trusses cost $50 each, welded, while the price asked for a riveted truss was $85. A load test was made to satisfy the city bureau of buildings; two trusses and a crane bracket were loaded to twice the designed load without failure. Some time later a building 40 ft. square was erected at Schenectady. This is noteworthy because its construction was preceded by tests made at Union College to determine the amount of arc-deposited metal required for the necessary strength in the welded joints.

Two arc-welded buildings were erected by the Chicago, Burlington & Quincy R.R. at Eola, Ill., in 1923, under the direction of H. T. Krausch, engineer of buildings of the railroad. One of them, a building of mill type, was exactly duplicated in a riveted building, and the relative costs are given as $786.20 for the welded against $1,339.50 for the riveted building.

In 1925, a welded garage and sales building was erected in Canton, Ohio. This was the first or one of the first examples of the application of welding to the connections of a tier building. About the same time, the beams of a building addition in Toledo were connected to the outer columns of the old building by welding in place of riveting, partly to avoid the necessity of removing the entire column encasement to make the connection. Since then, much advance has been made in this country in structural welding.

An application of welding in quite a different field is shown by the lower view in Fig. 2, the underframe of a car of the Australian Rys. Such cars have been in successful operation for more than five years, it is reported.

Impact resistance of arc-welded joints has been questioned by structural engineers, and this doubt has led to some interesting tests. Some of these were reported a year ago by A. G. Bissell, in a pamphlet, "Arc Welding in the Building Industry." A test recently conducted by the author bearing on the shock-resisting ability of welded joints is illustrated by one of the views in Fig. 2. A 6-in. I-beam 18 in. long was welded to the face of two columns of the same cross-section, which in turn were welded to a base plate and to a cap made of two 4x$\frac{3}{8}$-in. bars. Several blows of a steam hammer produced the result shown by the photograph.

Success in utilizing structural welding calls for full recognition by the designer and detailer of the new possibilities presented by welding, and also requires the avoidance of forms of design that may introduce needless weakness. In riveting it is necessary to lap the parts to be connected, or to cover butt joints with splice plates. Welded connections are often most conveniently made by butting, and frequently the butted joint will be stronger, cheaper and lighter. The crane

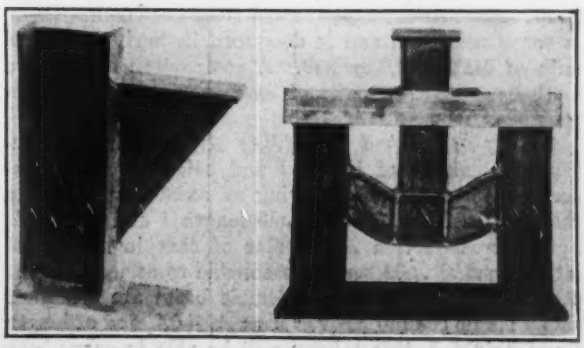


FIG. 3—CRANE BRACKET AND IMPACT TEST PIECE

bracket shown in Fig. 3 illustrates a use of butt joints. Such brackets, as well as complete plate girders, may be made from flat plate or bar material without the use of angles.

Overhead welding should be eliminated or reduced to a minimum in structural work. Such welding is difficult for even the most expert welders, and at best is much slower than downward or vertical welding. It is proper to remember also that vertical welding is somewhat slower and less easy than downward welding. Details should therefore be worked out so as to use downward welding to the maximum, and overhead welding only where it cannot be avoided. The connection of a beam to the face of a column may be made by welding a bar or angle bracket to the column in the shop (which requires no overhead welding) and using only side and downward welds to connect the end of the beam to the column face after setting it on the bracket. The connection may be reinforced by a splice plate on top of the beam, narrower than the beam flange, its end welded to the face of the column and its sides welded to the top of the beam flange.

In general, the designer can do much to cheapen and improve the job and help the welder. The limitations on him will be no more severe than those of riveted work, where it is necessary to locate rivets so that they can be driven.

Add-Area Method for Columns with Eccentric and Lateral Loads

Design Method Gives Results in Fair Agreement with Theory and Closer than Does Method of Reducing the Unit Load

By E. W. Rettger
Professor of Mechanics of Engineering, Cornell University

A THEORETICALLY correct treatment of a column subject to lateral loading results in an equation or formula so cumbersome and involved that it is of little use as a practical formula. In practice, when designing a column subject to lateral loading a comparatively simple approximate formula or method is used. The author has been accustomed to use the method of adding areas, that is, "Add to the area required by the column formula, the area required as a beam." Some recent books on strength of materials and on columns make no reference to this method of design. However, it appears logical, safe and simple, and more exact than others that are used. The method of adding areas was suggested in Johnson, Bryan & Turneaure's "Modern Framed Structures," Part III, p. 91. Another method, that of reducing the unit load, is sometimes used and is described in Seely's "Resistance of Materials," p. 248. A comparison of the two methods with the results of exact analysis is given in the following:

Theory of Method of Adding Areas—Given a rectangular column of length l and height h and cross-section A_1, capable of carrying an axial load P, and a rectangular beam of the same length l and height h, but of cross-section A_2, capable of carrying a central lateral load Q. It seems reasonable to assume that if the simple column and the simple beam are combined into a single column of area $A = A_1 + A_2$ and of length l and height h, this column will be able to carry both the axial load P and the lateral load Q. Assume that the straight line working column formula is to be used. The area required for the column to carry the axial load P is then $A_1 = P/(b - ml/r)$. In the beam, if the bending moment at the middle produced by the load Q is M, the required section modulus is $I/c = M/s$; and, since $I = A_2r^2$, $A_2 = Mc/sr^2$. If now the column and the beam are combined into a single column of the same length l and radius of gyration r, then the area of the resulting column is

$$A = A_1 + A_2 = P/\left(b - m\frac{l}{r}\right) + Mc/sr^2 \qquad (1)$$

and the column ought to be able to carry the axial load P and the lateral load Q.

In applying the formula it is simplest to try a given column. With the known radius of gyration and area of this column, calculate the bending moment due to the lateral loading, substitute the values of P, M, c, s, r and l in the right-hand member of the formula and if the resulting area is not greater than that of the assumed column, this column is satisfactory. If not try another column of larger or smaller radius of gyration.

The case of a column with eccentric load is the same as for a lateral load, with the moment of the eccentric load substituted for the moment of lateral load. If e is the eccentricity, Pe is the bending moment and hence the required area is

$$A = A_1 + A_2 = P/\left(b - m\frac{l}{r}\right) + Pec/sr^2$$

As more or less typical of other approximate methods in use one known as the method of reducing the unit load may be cited. The lateral load Q when acting alone is assumed to produce a deflection Δ at the middle of the column creating a bending moment of $P\Delta$. The unit stress due to this moment is

$$S' = P\Delta c/I = P\Delta c/Ar^2$$

Also the unit stress due to the bending moment M at the center of the beam caused by Q acting alone is $S'' = Mc/I = Mc/Ar^2$ and the allowable axial load is

$$P/A = b - ml/r - P\Delta c/Ar^2 - Mc/Ar^2 \qquad (2)$$

I propose to show that the method of adding areas gives results in very fair agreement with the theoretically correct results and more nearly so than the method of reducing the unit load. It will be convenient to consider first the eccentrically loaded column.

Column Loaded Eccentrically—The theoretical treatment of a column with an eccentric load leads to the secant formula which differs from other column formulas (straight line, parabolic or Rankine's) in that it gives actually the unit stress that a load with a given eccentricity produces in the outer fiber. It may be written in two ways depending upon the definition of safe or working load.

(1) The safe load is that load which actually produces the allowable unit stress in the outer fiber. Taking 16,000 lb. per sq.in. as the safe stress for mild steel,

$$16{,}000 = P/A\left(1 + \frac{ec}{r^2}\sec\frac{l}{2r}\sqrt{\frac{P}{AE}}\right) \qquad (3)$$

(2) Or, the safe load may be defined as the ultimate divided by a certain factor of safety. Taking the ultimate as the yield point, 36,000 lb. per sq.in., and assuming a factor of safety of 2.25

$$16{,}000 = P/A\left(1 + \frac{ec}{r^2}\sec\frac{l}{2r}\sqrt{\frac{P}{AE_w}}\right) \qquad (4)$$

where $E_w = E/2.25$.

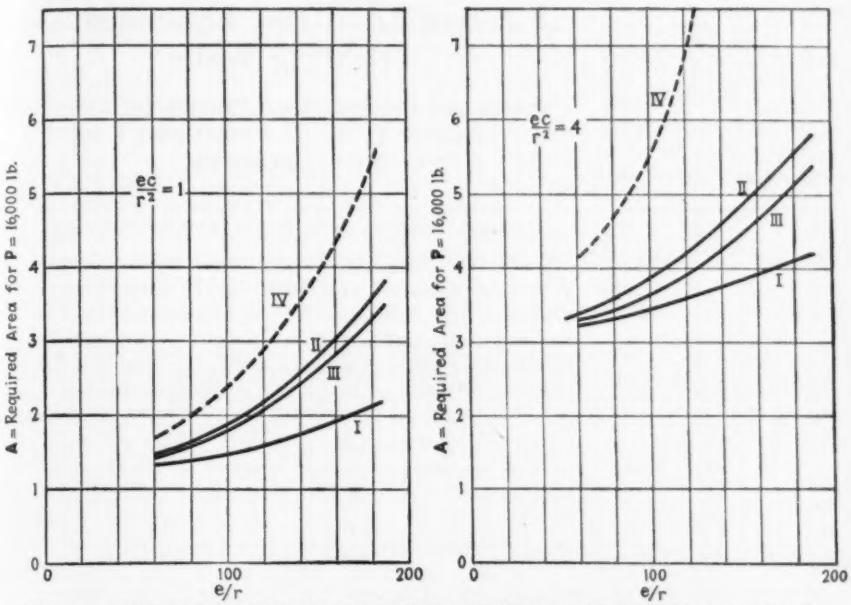


FIG. 1—CURVES REPRESENTING DESIGN FORMULAS, THEORETICAL AND APPROXIMATE, FOR ECCENTRICALLY LOADED COLUMNS

Curves I and II—By secant formula using different definition of working load in each case; Curve III by adding area method; Curve IV—by method of reducing unit load.

Because of initial crookedness, accidental eccentricity, etc., an ordinary column will behave just as an ideal column loaded eccentrically. The equivalent eccentricity depends upon the slenderness ratio l/r and as an average value may be taken so that $ec/r^2 = 0.20$. Since the straight line formula (or the parabolic or Rankine) is based upon the ultimate load, the corresponding working secant formula for a simple column is obtained by putting $ec/r^2 = 0.20$ in equation 4. That is,

$$16{,}000 = P/A\left(1 + 0.20 \sec \frac{l}{2r}\sqrt{\frac{P}{AE_w}}\right) \qquad (5)$$

Now by designating the value of P/A satisfying equation 5 as p, and assuming that the column is loaded with an eccentricity e, the method of adding areas gives as the required area of the column

$$A = P/p + Pec/sr^2 \qquad (6)$$

which is the same as equation 1 if p is put for $b - ml/r$. On the other hand the method of reducing the unit load (equation 2) gives

$$P/A = p - P\Delta c/Ar^2 - Pec/Ar^2 \qquad (7)$$

To compare the four formulas, 3, 4, 6 and 7, curves may be drawn giving the required area for a given slenderness ratio. In Fig. 1 two sets of curves are drawn, one for $ec/r^2 = 1$, and the other for $ec/r^2 = 4$, in each case, using a factor of safety of 2.25. Curve I gives the area required if the working load is that which will produce actually a unit stress of 36,000/2.25 or 16,000 lb. per sq.in. in outer fiber (formula 3). Curve II gives area required if working load is taken as ultimate load divided by $n = 2.25$ (formula 4). Curve III gives area required if method of adding areas is used (formula 6). Curve IV gives area required if method of reducing unit load is used (formula 7).

It will be noticed that curve III obtained by the method of adding areas lies between curves I and II and that for the smaller eccentricity, curve III lies close to curve II while for a larger eccentricity it moves down toward curve I. This, it seems to the author, is just what is wanted, for as the intentional eccentricity is increased the actual unit stress in the outer fiber may be given greater consideration. It should also be noticed that curve IV obtained by the method of reducing the unit load gives a required area much too large since this certainly need not exceed that given by curve II.

In the case of a column subject to an axial load P_1 and an eccentric load P_2 the method of adding areas gives the equation:

$A = (P_1 + P_2)/p + P_2ec/sr^2$.

Columns Subject to Lateral Loading—A theoretically correct treatment of a column subject to lateral loading is not a simple matter. By letting P = axial load and Q = lateral load and assuming an equivalent eccentricity of P such that $ec/r^2 = 0.20$, the mathematical analysis gives:

$$s = P/A\left(1 + 0.20 \sec \frac{l}{2r}\sqrt{\frac{P}{AE}}\right) + 1/4\,\frac{Ql}{Z} + 1/48\,\frac{Ql^2}{EI}\cdot\frac{P}{Z} + \cdots\cdots \qquad (8)$$

where s = unit stress actually produced in outer fiber, and $Z = I/c$. The first term of the right-hand member is the unit stress produced by P acting alone, second term $= Mc/I$ = unit stress due to Q acting alone, and third term $= P\Delta c/I$ = unit stress due to moment $P\Delta$ where Δ = deflection of middle of column due to Q acting alone. The other terms after the third usually have only a secondary effect. This formula may be written in two ways depending upon the definition of P and Q as safe loads.

(1) P and Q may be defined as safe loads if together they produce the safe working stress in outer fiber. Then

$$16{,}000 = P/A\left(1 + 0.20 \sec \frac{l}{2r}\sqrt{\frac{P}{AE}}\right) + 1/4\,\frac{Ql}{Z} + 1/48\,\frac{Ql^2}{EI}\,\frac{P}{Z} \qquad (9)$$

(2) Or, if P' and Q' are a set of values that will produce the ultimate stress 36,000 lb. per sq.in. in outer fiber, the safe loads may be defined as $P = P'/n$, and $Q = Q'/n$ where $n = 2.25$ for mild steel. Substituting 2.25 P and 2.25 Q for P and Q in equation 8,

$$16{,}000 = P/A\left(1 + 0.20 \sec \frac{l}{2r}\sqrt{\frac{P}{AE_w}}\right) + 1/4\,\frac{Ql}{Z} + 1/48\,\frac{Ql^2}{E_wI}\,\frac{P}{Z} \qquad (10)$$

Formulas 9 and 10 are not the same since one contains E and the other contains $E_w = E/2.25$.

Now by letting p = allowable unit load, if $Q = 0$, that is, p is the value of P satisfying equation 5, of adding areas, gives

$$A = \frac{P}{p} + 1/4\,\frac{Qlc}{sr^2} \qquad (11)$$

or in general $A = P/p + Mc/sr^2$.

The method of reducing unit load gives

$$P/A = p - 1/4\ \frac{Ql}{Z} - 1/48\ \frac{Ql^2}{EI} \cdot \frac{P}{Z} \qquad (12)$$

To compare the formulas 9, 10, 11 and 12, it will be convenient to take a number of columns and for each column plot curves giving the allowable values of Q as determined by each of the formulas for a given unit

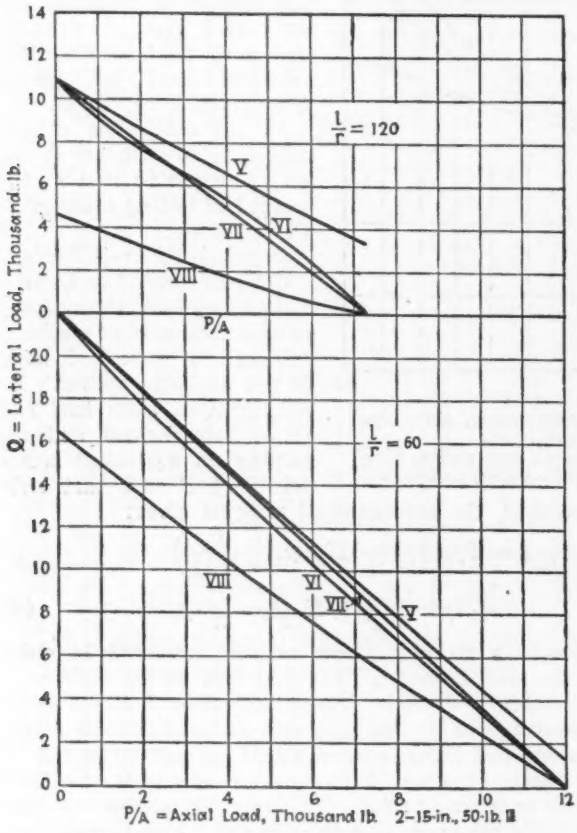


FIG. 2—DESIGN CURVES FOR LATERALLY LOADED COLUMNS

Curves V and VI—Theoretically exact; Curve VII—by method of adding areas; Curve VIII—by method of reducing unit load.

axial load P/A. In Fig. 2 these curves are drawn for a column made of two 15-in. 50-lb. channels. Two cases are given, one for $l/r = 120$ and the other for $l/r = 60$. These curves are typical, in each case, using a factor of safety of $n = 2.25$. Curve V is based upon formula 9, that is P and Q produce the unit stress of 36,000/2.25 = 16,000 lb. per sq.in. in the outer fiber. Curve VI is based upon formula 10, that is $P = P'/2.25$ and $Q = Q'/2.25$ when P' and Q' together produce the ultimate stress of 36,000 lb. per sq.in. in the outer fiber. Curve VII is based upon formula 11, the method of adding areas. Curve VIII is based upon formula 12, the method of reducing the unit load.

Curve VIII obtained by the method of reducing unit load lies considerably below curve VI. Moreover, curve VIII fails to satisfy, even approximately, one of the limiting conditions, i.e., if $P = O$ we have the case of a simple beam and all four curves should go through the same point on the Q axis.

In conclusion, the writer is of the opinion that the method of adding areas is the logical method to use both for an eccentrically loaded column and for a column subject to lateral loading.

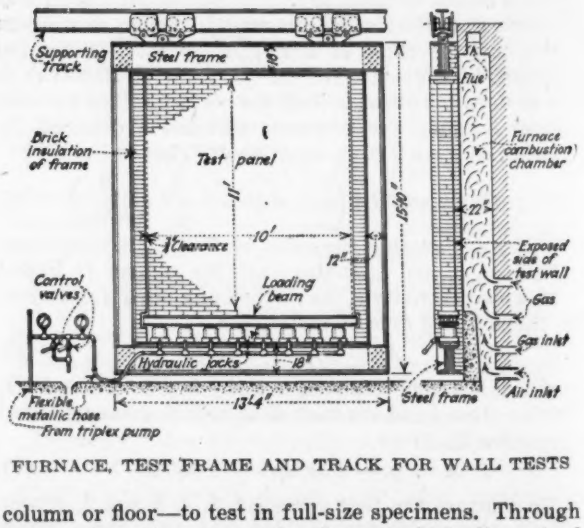
Fire-and-Load Test Equipment for Bearing Walls

Furnace and Loading Panel Provide for Fire Tests of 10x11-Ft. Walls While Under Load Up to 500,000 Lb.

By C. A. Menzel
Assistant Engineer, Underwriters' Laboratories, Chicago

An interesting piece of equipment has recently been designed and built by Underwriters' Laboratories, Inc., Chicago, for use in making fire tests of bearing walls under full load. In the development of this loading equipment advantage was taken of the experience of the Bureau of Standards with similar equipment designed for the same purpose. The Laboratories' equipment, designed by and built under the direction of B. H. Glover, equipment engineer, is capable of taking wall panels 10 ft. and 11 ft. high, and subjecting them to standard fire exposure on one side while under vertical compressive load up to a total of 500,000 lb.

It will be remembered that one of the principal activities of Underwriters' Laboratories is the determination of the performance of walls, columns, floors and other building members under fire-test conditions. Elaborate special equipment has been provided for carrying out such determinations, to make it possible to put any form of structural element—wall, partition,



FURNACE, TEST FRAME AND TRACK FOR WALL TESTS

column or floor—to test in full-size specimens. Through this work much progress has been made in the art of fire testing and in the classification of the performance of various types of construction and materials. The new machine supplements this equipment in an important way.

The general arrangement of the equipment is represented in the accompanying sketch, which shows how the test wall panel is carried in a strong rectangular steel frame, hung from an overhead track in such a way that it can be drawn in front of a vertical gas furnace and exposed to the fire in its combustion chamber. The steel frame not only supports the wall panel but provides for subjecting it to a vertical load distributed along the entire length of the panel and for maintaining this load during the test.

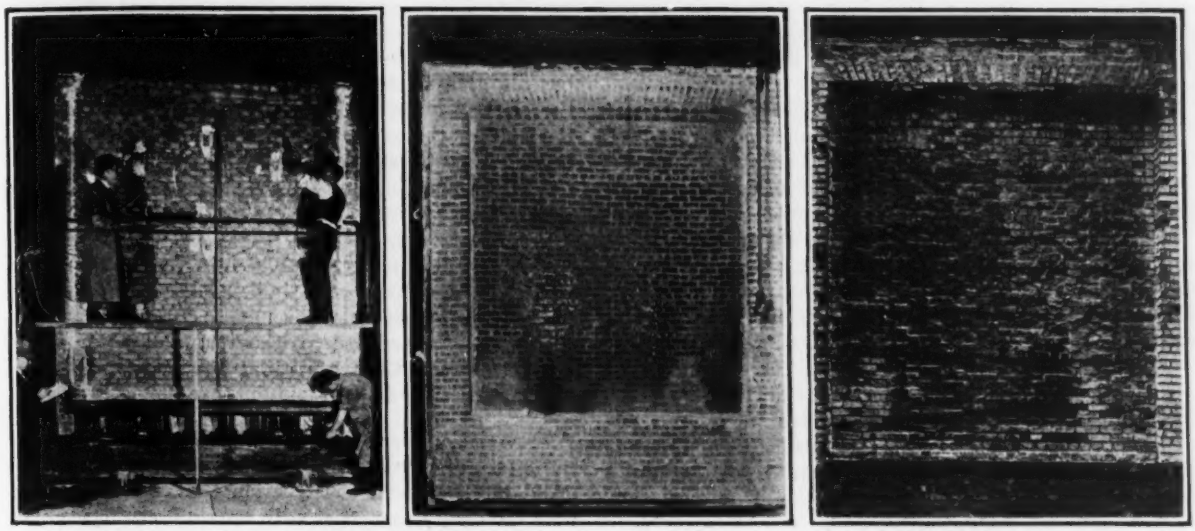
Insulation of the frame is provided by brick masonry. The panel opening in this masonry frame is large enough

to receive a test panel 10x11 ft., and leave a ¾-in. space on either side along the vertical edges to permit expansion or deflection of the test panel. Passage of flame through this clearance space is prevented by a packing of asbestos fiber or other suitable insulation.

Resting on the lower part of the supporting frame are 8 jacks spaced 15 in. apart, which carry a loading beam on which the test wall panel is built. At the top, the wall bears against the upper frame member. By applying hydraulic pressure to the jacks it thus is possible to load the wall as desired, up to the full capacity of the jacks. These have plungers 5½ in. in diameter by 6½-in. stroke; water is supplied by a motor-driven triplex pump in the basement, by way of piping controlled by bleeder or bypass valves as indicated. The pump, which has plungers ¾x6 in., is capable of delivering 1 gal. per min. at a pressure of 5,000 lb. per sq.in. The combined plunger area of the jacks is 190 sq.in., so that the test-frame capacity of 500,000 lb. is reached by a hydraulic pressure of 2,630 lb. per square inch.

As the fire-resistance time classification of a bearing wall or partition is contingent on the performance of two similar test samples, one subjected to a fire-endurance test under rated load, and the other to a fire-and-water test (fire exposure under rated load for one-half the fire-endurance period, but not to exceed 1 hr., followed by application of a standard fire stream to the incandescent inner face, this in turn followed after cooling but within 72 hr. by loading up to twice the rated load), two structural steel test frames are provided, so that both specimens of a wall test program can be built at the same time and tested in succession. A third frame, of lighter capacity (250,000 lb.), is provided for auxiliary service. Each frame has its individual supporting trolleys, but the same hydraulic jacks can be used in all of them, the jacks being portable.

The capacity of this equipment is ample for tests of solid masonry walls up to 12 in. thick. Three views of an 8-in. brick wall during and after test are shown in the accompanying photographs. This wall was subjected to fire test while under a load of 163,000 lb. (170 lb. per sq.in. of bearing area) and immediately after removal from in front of the furnace was subjected for 2¾ min. to the cooling, impact, and eroding action of a water stream discharged from a 1⅛-in. nozzle 20 ft. from the wall under 30 lb. pressure. After cooling, the wall withstood a load of 400,000 lb.



TEST PANEL OF BRICK BEARING WALL IN FIRE AND WATER TESTS WHILE UNDER LOAD

At left, outer face of test panel during progress of fire test. At middle, inner or fire side of wall just after being removed from the furnace exposure, the brickwork still largely incandescent. At right, the fire side after the fire stream had been applied to the wall when in the condition shown by the preceding view. When the wall cooled, it withstood a load of 400,000 lb.; the load during the fire test was 163,000 lb., or 170 lb. per sq.in. of bearing area.

Concrete Finish of Grout with Calcium Chloride

IN BUILDING the Charley Creek bridge for the California Highway Commission the following method of fine finishing was employed. As soon as the forms were stripped, a cement grout was applied to the surfaces with a paint brush. The grout consisted of two parts of portland cement to one part of fine sand to which was added calcium chloride equal in amount to 5 per cent of the portland cement in the mixture. The calcium chloride was added to hasten the setting of the grout. The time for setting of the grout depended upon weather conditions, varying from 5 hours in warm weather to 48 hours in rainy weather. For the finish of the hand rail and curb, pure hydrated lime was added to the cement grout to obtain a lighter color for the rail, making the rail more visible at night and at the same time adding to the appearance of the structure. After the mortar had sufficiently set, the grout coat was thoroughly wet with water and rubbed with a carborundum stone until a lather was formed and the air pockets filled. It was then brushed out to a smooth and uniform surface with a wet brush.

Redwood was used for the forms of the hand rail. It was found this material had no tendency to warp. The surface of the rail needed very little working over for the purpose of removing form marks and projections, and its appearance and the small cost of finishing fully justified the use of the redwood for the forms.

Bordwell & Zimmerman of Napa, California, were the contractors. W. H. Johnson was the resident engineer in charge of the work under the general direction of the bridge engineer, Harlan D. Miller. The bridge contained 1,720 cu.yd. of concrete and cost $66,000.

Bascule Bridge with All Mechanism Below the Deck

Six-Track Plate-Girder Bridge in Four Parallel Units—Trunnions Mounted on Tall Steel Bents—Construction Kept Clear of Main Tracks—Cars Haul Concrete from Mixer Plant

A SIX-TRACK bascule bridge having an 85-ft. plate-girder deck span, with all operating machinery and the counterweights housed below rail level, was built in 1925 by the Illinois Central R.R. for its crossing of the Little Calumet River at Riverdale, just south of Chicago. In connection with track elevation at this point it was necessary to build a new bridge, and as this river is classed as a navigable stream (though not now navigated) the War Department required that a drawspan should be provided to permit future navigation.

To meet this requirement, a special design was made for a bascule bridge of the trunnion type, to be built as a fixed span, resting on its end seat and trunnion bearings. The operating machinery, counterweights and end-lock apparatus will be installed at some later time when the opening of the bridge becomes necessary. Two flanking spans of 60 and 65 ft. complete the new structure, which is shown in Figs. 1 and 2. The old structure, prior to 1919, consisted of one 171-ft. double track through plate-girder draw span, with one single-track 40 ft. deck plate-girder span for each track at the south end, all resting on dressed stone masonry. In 1919, two additional tracks were provided. For these, two 90-ft. single-track plate-girder through spans on pile piers were set to the west of and opposite the south arm of the draw, flanked with an open deck pile trestle approach at either end.

Bascule Span—In the present arrangement, there are six tracks, spaced 13 ft. c. to c., except that the last two tracks on the west side are spaced 26 ft., leaving room for a future seventh track, so that the total width over the girders is about 87 ft. From the cross-section, Fig. 3, it will be seen that across the river channel each track is carried by a pair of girders, spaced 8 ft. 10 in. c. to c. In addition to the cross frames and lateral bracing for the girders of each track, it will be noted that the adjacent girders of tracks 2 and 3 and tracks 4 and 5 are also connected by bracing so as to form two double-track structures. Ordinarily the entire bridge, thus consisting of two single-track and two double-track units, will be operated simultaneously by six motors on the trunnion pier, geared to line shafting having an operating pinion for each girder. In case of needed repairs, the double-track spans can be separated from the other units, so that the span needing attention can be left in the open position while repair work is done, leaving the remainder of the bridge in operation. When fully open, the bascule span will stand at an angle of 77 deg. from the horizontal.

Each of the bascule girders, Fig. 4, is 10 ft. deep and has a ½-in. web-plate reinforced by additional plates at the hole for the trunnion, which is a pin 16½ in. in diameter and 3 ft. 8½ in. long. The top chord is of double channel section, formed by four angles, with reinforcing plates riveted against the vertical legs of the angles. This chord has no cover plates. The bottom chord has two flange angles and three cover plates. Below the trunnion and under the bottom chord are two segmental rack plates, 6 in. apart, between which the cast steel rack is fitted and secured by turned bolts. In the tail end of the girder is a hole for a 6½-in. pin, 15½ in. long, from which the counterweight is suspended.

These girders are 105 ft. long, including the 17-ft. tail ends. As their tail ends extend beyond the pier and into the adjacent 60-ft. fixed span, the girders for each track of the latter span are spaced only 6 ft. c. to c., so as to fit inside the 8 ft. 10 in. spacing of the bascule girders, as shown by Fig. 3. To provide for the electrification, which will soon be extended across the bridge, the girders have structural steel brackets to carry posts with overhead transverse and longitudinal ribs and bracing for the support of the overhead trolley-wire system.

For the tracks, 90-lb. rails are laid on tie-plates on long-leaf yellow-pine ties 10x10 in. and 12 ft. long, spaced 14 in. c. to c., each tie being bolted to the flange angles of the bascule girders to prevent creeping. Inside 75-lb. guard rails, without tie-plates, are spaced 8 in. clear from the track rails; outside guard timbers 6x8 in., dapped 2 in. and laid flat, are bolted to the ties.

Trunnion Tower—In view of the approaching electrification of this part of the line, it was necessary to avoid any overhead construction that would interfere with the trolley line. But with the counterweights hung below the tail ends of the bascule it was necessary to provide room for them to swing under the trunnion bearings as the bridge opens. This condition made it impracticable to carry up a masonry pier to support the trunnions. The plan adopted was to build this pier a little above high water level and on it to erect steel bents 31 ft. high, capped by the trunnion bearings, as shown in Fig. 3. Then the counterweights were designed to swing between these bents. With this arrangement there can be no continuous bracing to form a tower, but the bents are partially connected transversely and the end bents have brace bents seated on the pier, as shown.

These steel bents are shown in Fig. 5. In the ordinary construction, the trunnion post is composed of four angles and two 17-in. web plates with tie-plates on the open sides, while the bracing post has four angles laced on two sides. A transverse 12-in. I-beam carries an oak bumper to engage the tail ends of the bascule girders when the span is in full open position. Bracket plates on the brace posts of all bents form supports for the line shafting, while bracket plates on the trunnion posts of the intermediate bents carry pin bearings for the counterweight links.

Certain of the tower bents, however, have to carry the girders of the adjacent 60-ft. fixed span. Here the trunnion post has web plates 34 in. wide and is reinforced by a transverse 10½-in. web plate or vertical diaphragm riveted to a pair of interior angles. The brace post is composed of four angles and two web plates. At the top of the bent, the land side of the trunnion post is cut away and carries a 4½-in. pin form-

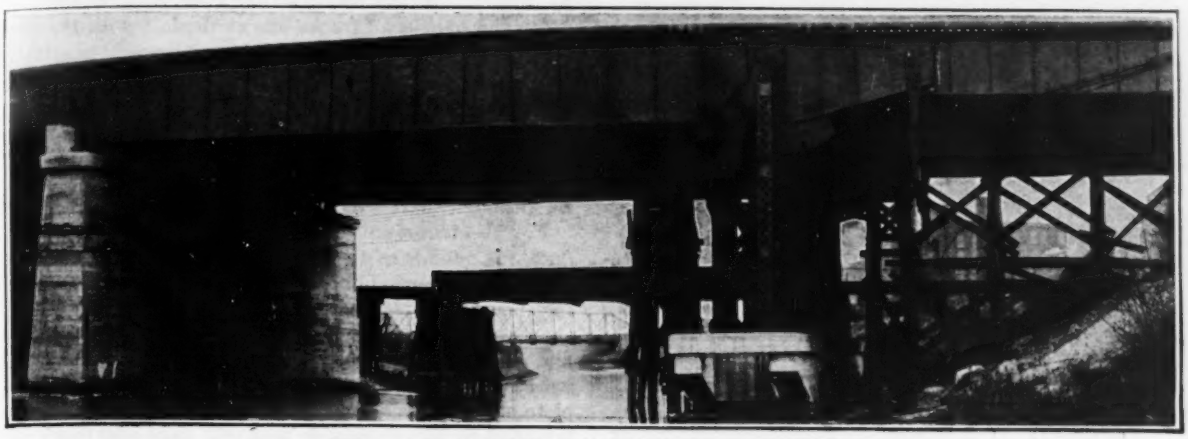


FIG. 1—DECK-GIRDER SIX-TRACK BASCULE BRIDGE
Note segmental rack girder under trunnion, and hanger for counterweight at tail of bascule girder. Plate-girder bridge beyond carries low-level side track.

ing the shoe bearing of the fixed girder. A vertical member seated on the brace post supports a 15-in. I-beam which carries the bridge deck from the end of the fixed span to the break in floor of the bascule span.

Concrete cantilever brackets on the west end of the trunnion pier will carry a tower for the operating house. Platforms on the bents will support the operating machinery, which is of simple design, as already noted. No end locks will be fitted until this machinery is installed, and for the present, while the structure constitutes a fixed bridge, no end rail connections are placed, the track rails being laid continuously across the bridge.

Underhung Machinery—In view of the number of tracks, the great width of the structure, and the installation of overhead trolley wires in the near future, it was not desirable or economical to provide a tower over the tracks to carry the machinery and counterweights, and a special feature of the design is that all this equipment is arranged beneath the tracks. The operating racks are attached to the bottom chords of the girders, as noted above, and the counterweights will be suspended from the tail ends of these girders. These counterweights will swing through between the steel bents carrying the trunnion bearings and machinery, and in order to provide sufficient weight to balance the span, there will be but little clearance from the columns. With the bridge closed, the counterweights will be housed between and below the tail ends of the bascule girders. For each counterweight, there are two triangular steel trusses suspended from pins in the girders and embedded in a concrete block of the form shown. In swinging, the block is guided by a pair of bars or links pivoted to pins in the block and on the steel bents. These counterweights weigh from 101 to 132 tons each, with a total of 688 tons.

Steel Erection—Four tracks were kept open to traffic during construction and erection work. Starting from the east side, the steel for new track 6 was erected first, track 5 having been put out of service. Steel for track 6, with the exception of the bascule spans, was placed from track 6 by derrick cars. Girders for the bascule span were set from track 5. Steel for track 5 was then set from track 6 with derrick cars, tracks 1, 2, 3 and 4 being open to traffic. Steel for track 4 was in turn set from track 5, tracks 1, 2, 3 and 6 being open to traffic. This method was continued across to track 1, which was set from track 2. All erection was handled from above with derrick cars, the track under construction and the one next east of it being put out of service.

Substructure—A trunnion pier, a rest pier and two

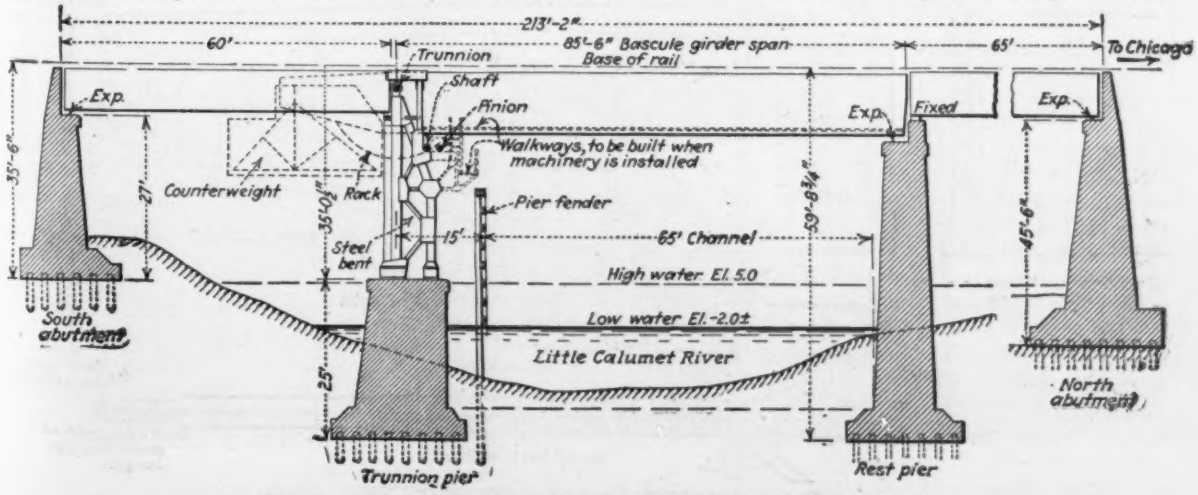


FIG. 2—LITTLE CALUMET RIVER BRIDGE; ILLINOIS CENTRAL R.R.

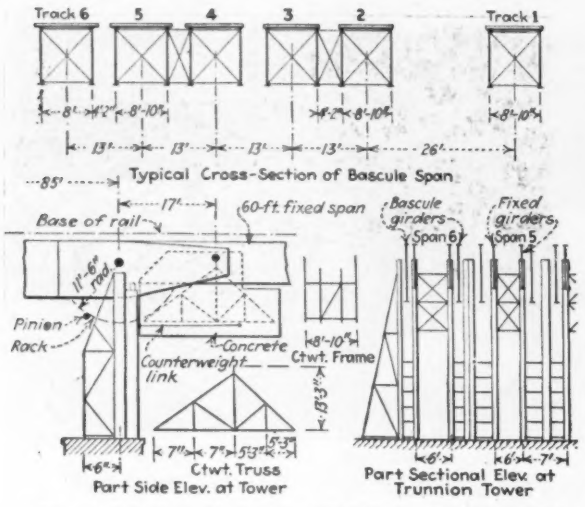


FIG. 3—TRUNNION TOWER AND SECTION OF BASCULE

abutments constitute the substructure. The piers are of monolithic concrete without reinforcement, but the abutments are of a semi-reinforced type, made considerably thinner than the standard gravity design and having bars in the back to take the tension. All these are founded on wood piles in a gravel formation. At the south abutment, creosoted piles are used, as it is on relatively high ground, with its footing above high-water level. This substructure involved the placing of 7,400 cu.yd. of concrete, 1,529 piles and 58 tons of reinforcing steel. It was commenced in October, 1924, and completed on April 1, 1925, one month ahead of the contract time. The working force averaged 100 to 150 men.

Substructure Work—Construction of the foundations and substructure was attended with difficulties due to the lack of room, the necessity of keeping clear of traffic over the old four-track high-level main tracks and the single low-level transfer track. This work was complicated also by the presence of falsework which had been built to carry the high-level tracks during the reconstruction work, to permit the removal of the two old masonry piers. This temporary structure is shown by Fig. 6. In the construction view, Fig. 7, the new piers and high-level tracks are at the left with the low-level transfer track at the right. All work had to be done without occupying or interfering with the railroad tracks. Cofferdams of 26-ft. steel sheetpiling were built, the piles being driven with a portable steam pile-hammer. Only one row of sheeting was necessary, as the blue clay was so dense that very little water came in, although there was a head of about 20 ft.

For the trunnion pier, the river front of the cofferdam was outside of the falsework, while the wings were inside and extended back into the bank. No steel sheeting was used on the land side, where 3-in. timber sheeting was placed. For the rest pier the river side and east wing of the cofferdam were outside the falsework, while the back was inside the falsework. A complete steel cofferdam was required for this pier, as the material on the shore side was soft sand and muck for about half way down, where the clay was reached.

Excavation was done with compressed-air spades, the material being handled by buckets and derricks and dumped into 1-yd. narrow-gage cars which were run about 100 to 300 ft. to a dump. The depth from base of rail to bottom of concrete was about 60 ft.

Timber foundation piles were driven by steam hammers and a drop hammer, giving an average penetration of 18 ft. below cutoff. At two of the foundations an overhead traveling crane was rigged beneath the temporary bridge to carry the steam hammer, as there was no room for a derrick from which to sling the hammer. The crane bridge, 25 ft. long, was mounted on grooved wheels on rails laid upon timber wales bolted to the falsework at about 6 ft. below base of track rails. On the crane bridge was a traversing trolley from which the steam pile hammer was suspended, so that with the movements of the crane and trolley the hammer could be spotted over any desired location.

For handling excavation, piling and cofferdams there were three stiffleg derricks with 50-ft. booms and a self-propelling locomotive crane. On one side of the main-line fill, the railroad has a transfer track on the ground level; the crane track was laid between this transfer track and the fill so that the boom could reach under the bridge. On the other side of the fill, at ground

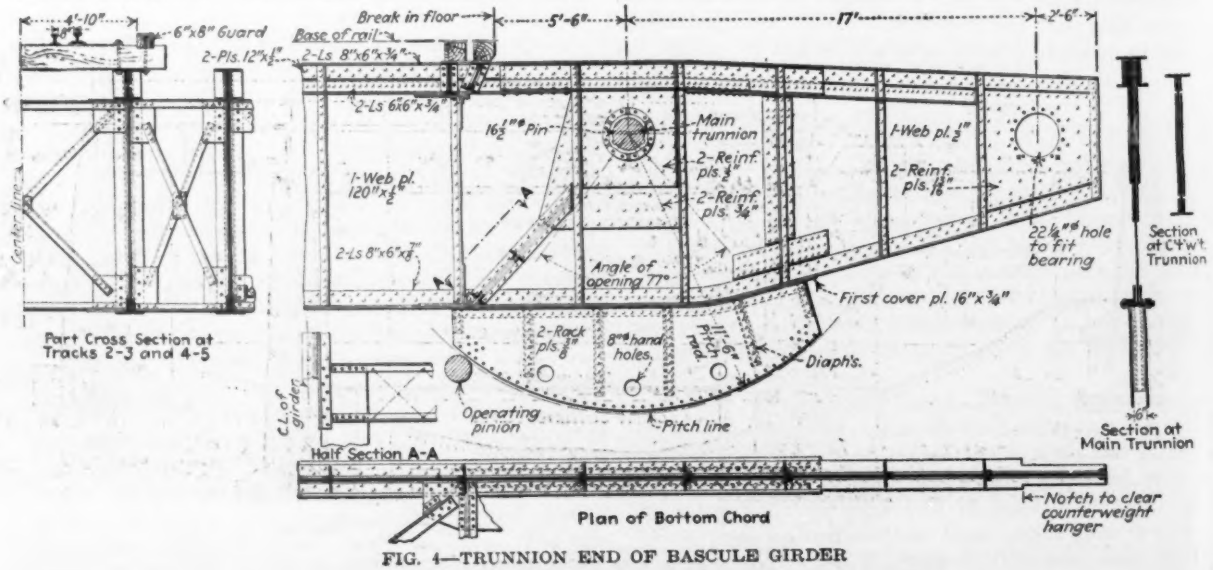


FIG. 4—TRUNNION END OF BASCULE GIRDER

level, were the derricks, so placed that the booms would clear the steel spans and reach under them. The headroom above water level was about 35 ft.

Handling Concrete—Haulage of concrete from a mixer plant about ¼ mile north of the bridge was made necessary by the fact that at no nearer point was it practicable to locate this plant. It was placed on low

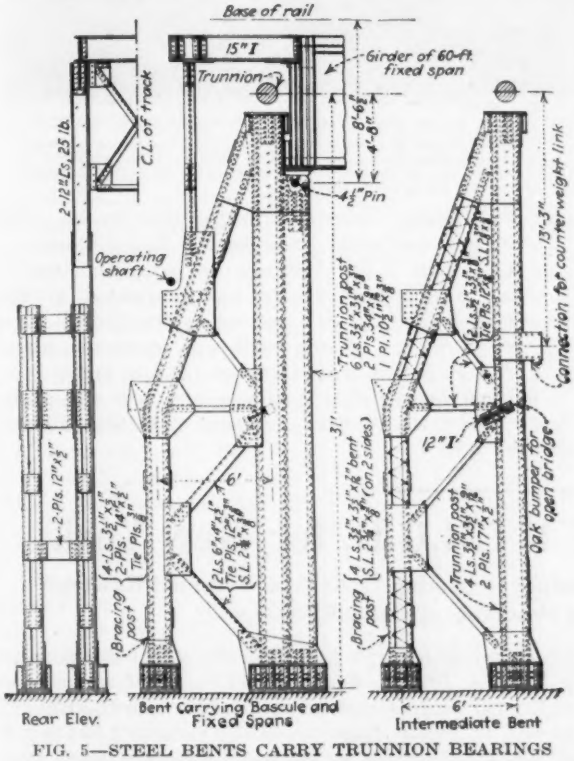


FIG. 5—STEEL BENTS CARRY TRUNNION BEARINGS

ground on the east side of the railroad fill. All material was brought in on railroad cars, the gravel and sand being unloaded by derricks into a stockpile sufficient for about 3,000 cu.yd. of concrete, as shown by Fig. 8. Cement was stored in a shed.

Derricks delivered the gravel and sand to bins of 30-yd. capacity over a 1-yd. mixer, which discharged the concrete into an elevator bucket in a wooden tower.

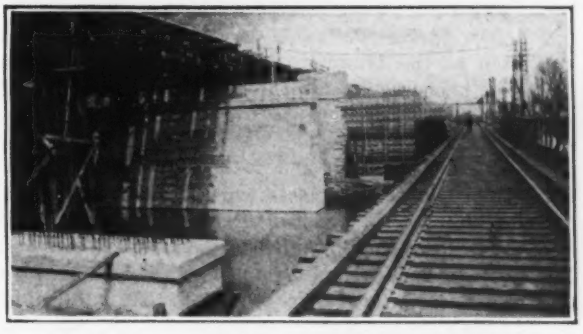


FIG. 7—SUBSTRUCTURE FOR NEW BRIDGE

Trunnion pier at left, with rest pier and abutment beyond. High-level main tracks on temporary structure at left. Low-level side track at right. In distance, note bridge for concrete trains spanning this track.

A bridge at main-track level, spanning the low-level transfer track, was run from the railroad fill to the tower, passing on one side of it, so that concrete could be spouted from the elevator bucket to the 1-yd. bottom-dump steel cars. These cars, with a gasoline locomotive, operated on a track of 24-in. gage laid along the shoulder of the fill. Trains of two or three cars were handled. Fig. 8 shows a locomotive with three cars standing at the tower ready to take a load of concrete.

For delivery to the forms of the trunnion pier and south abutment, the construction track was carried on a bridge cantilevered out from the falsework and from the outside of the 60-ft. temporary girder span over the main channel. The cars dumped the concrete into steel chutes which discharged at the required position. Reinforcing steel was secured by tie-wires so that it would not be displaced by the concrete. All form work was of wood.

As this was winter work, provision had to be made for heating the materials and protecting the concrete. Sand and gravel were heated by steam from a boiler, led to perforated pipes and well-points laid under the stockpiles and through jets into the hopper. This heating was continuous, whether or not concreting was in progress. During concreting, the water also was heated. At the end of each day, the concrete in the forms was protected by a complete canvas covering, under which coke-salamanders were kept burning.

FIG. 6—TEMPORARY BRIDGE DURING SUBSTRUCTURE WORK

Girders of channel span on timber towers. Steel cofferdam of rest pier in place at left. Completed trunnion pier at right, with trestle approach beyond.

Placing Anchor Bolts—A peculiar and troublesome condition at the trunnion pier was the placing of a forest of anchor bolts for the steel bents of the seven parallel track spans. There were 219 bolts, 3 in. in diameter and 4 to 12 ft. long. It was necessary to place these in exact position and to hold them in position while the concrete was placed around them. One main templet and several supplementary templets above it held the bolts in position. Below the main templet and 2 ft. above their lower ends, the bolts were held between two 2x8-in. sticks wired to the form. At mid-length of the bolts were temporary wooden braces. All supports were so closely spaced that it was not an easy matter to find places through which to pour the concrete. Careful instrument work was done by the railway engineers to insure exact location of the bolts to fit the future steelwork and maintain them in position.

Engineers and Contractors—The Calumet River bridge is designed for Cooper's E-60 loading, with an impact allowance of live-load squared and divided by live-load plus dead-load, according to the railway company's specifications. Its bascule span was designed under the patents of the Strauss Bascule Bridge Co., the details being worked out jointly by this company and the railway company's bridge department. The substructure was built by the Bates & Rogers Construction Co., with E. S. Whitney as superintendent in charge. The superstructure was fabricated by the American Bridge Co. and erected by the Strobel Steel Construction Co. All the work was under the direction of A. F. Blaess, chief engineer (at first under F. L. Thompson, former chief engineer and now vice-president); and C. C. Westfall, engineer of bridges, Illinois Central R.R.

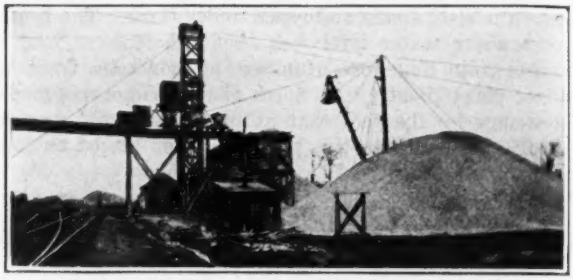


FIG. 8—MIXER PLANT AND CONCRETE TRAIN
Gasoline locomotive with three cars being loaded at elevator tower. Bridge spans the low level side track and extends to embankment of high-level main tracks. Material hoppers and stock piles at right.

Additional Water Supply of 434 M.G.D. for New York

Gravity Sources East of Hudson River with Aqueduct Delivering to Kensico Terminal Reservoir and Thence to Hill View Equaling Reservoir of Catskill System

A PLAN for an additional water supply of 434 m.g.d. for New York City, to be drawn from streams east of the Hudson River, has been submitted to the Board of Estimate and Apportionment by the Board of Water Supply. Except for 12 m.g.d. to be obtained from an undeveloped portion of the Croton drainage area, all of this additional supply would be impounded in a string of reservoirs extending northward from the present Croton drainage area nearly to Troy. All the water would be delivered into the present Kensico storage reservoir at the southerly end of the existing Catskill aqueduct. In addition to the 434 m.g.d. of new supply so delivered, 121 m.g.d. would be diverted from the present Croton system through three reservoirs in the Croton drainage area, one of which would be new, although two are from a portion of the Croton drainage area already drawn upon. By means of the diversion from these three Croton reservoirs over a third of the water from the Croton system, the safe yield of which is 336 m.g.d., may be delivered by gravity at a considerably higher elevation than is now possible.

The estimated cost of the additional supply of 434 m.g.d. is $347,934,000, of which about $183,000,000 is for new aqueducts, not including the cost of gate houses and control works, the balance being for dam and reservoir construction. The total sum named, however, does not include $67,249,000 for a new delivery tunnel from the Kensico reservoir through New York City, recommended by the Board of Water Supply, Dec. 30, 1924, but not yet acted upon by the Board of Estimate. This delivery tunnel, which is deemed highly necessary regardless of the proposed additional supply, would bring the total cost of needed water-supply construction up to $415,183,000. This does not include a final total investment in the new Catskill system which will altogether amount to $188,000,000 [$182,000,000 spent to Dec. 31, 1925]. With the 434 m.g.d. of water from additional sources east of the Hudson and the present sources of supply, there would be available 1,534 m.g.d. of safe yield against an estimated consumption in 1947 of 1,529 m.g.d., leaving a margin of only 5 m.g.d. The estimated time for completing the works recommended is 15 years, so assuming a beginning in 1927 the works on completion would, with the earlier works, give a safe yield already nearly exhausted by the prospective consumption.

The recommendations of the Board of Water Supply, summarized above, are based on a report made to the board by its chief engineer, Thaddeus Merriman, on Sept. 12. Both reports were submitted to the Board of Estimate on Oct. 14, with resolutions for approval of the plan, and were referred to the board's committee as a whole. Mr. Merriman's report is endorsed by J. Waldo Smith, John R. Freeman, and William H. Burr, consulting engineers to the Board of Water Supply. The members of the board are George J. Gillespie, president, James P. Sinnott and Philip F. Donohue.

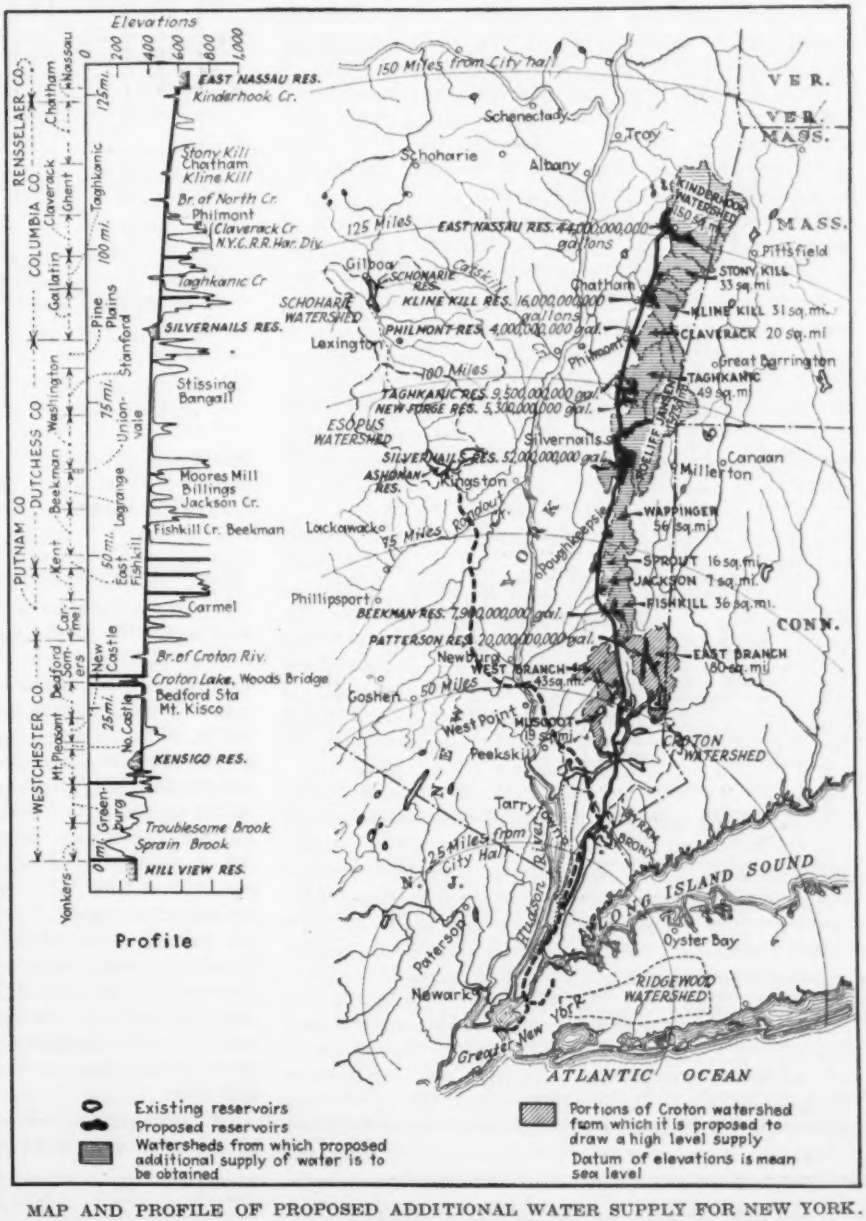
In the introduction to his report, Mr. Merriman states that during the past nine years the water consumption in New York City has increased at the average rate of over 31 m.g.d. per annum, the averages for 1916 and 1925 being 566 and 847 m.g.d. The total safe yield of all the sources of water supply of New York City is now 1,100 m.g.d., distributed thus: Catskill system, including the Bronx and Byram Rivers, 600 m.g.d.; Croton, 336; Ridgewood (old Brooklyn supply on Long Island), 90; various borough sources, 30; private water companies, 44 m.g.d. Of these sources only the Ridgewood could be developed to produce more, but that would yield only 30 m.g.d. additional; while among the

supplies furnished by borough sources and private companies, some are too hard for either domestic or industrial use and will ultimately be abandoned. With the annual rate of increase of 31 m.g.d., the present available margin of 253 m.g.d. would be absorbed in 8 years.

The average daily per capita consumption of water in New York and nine other large American cities, together with the percentage of services metered in each city for the year 1925, as given by Mr. Merriman, is noted in the table below.

From the table, Mr. Merriman states, it appears "that the use of water in New York is reasonable and conservative notwithstanding the relatively small proportion of" services metered—especially when the large number of transients in the city is considered. He adds: "Any economy in the use of water which can possibly be effected will be relatively small and cannot defer the complete exhaustion of all the existing water reserves much beyond the year 1935."

The plan recommended was decided upon after an investigation under Mr. Merriman's direction of "all physically possible sources of supply within a distance of 150 miles" of New York City. The Delaware River was dismissed, it may be noted in passing, according to the report of the Board of Water Supply itself, because of interstate complications and the delays in action that followed the report of the Tri-State Delaware River Commission, created in 1923 by the Legislatures of New York, New Jersey and Pennsylvania. Thus far New York State is the only one of the three that has approved the tri-state compact. Another possible supply outside the state is the Housatonic, but the board dismisses that, also, presumably for interstate reasons. There are bars in the way of New York State legislation to developing water for New York City in Suffolk County at the easterly end of Long Island and also, it is presumed, to taking water for New York City from Dutchess County; but it is assumed that the Dutchess County prohibitions may be done away with by the legislature if thought to be legally enforcible.



MAP AND PROFILE OF PROPOSED ADDITIONAL WATER SUPPLY FOR NEW YORK.

USE AND METERING OF WATER IN LARGEST CITIES

City	Average Daily Per Capita Use 1925, Gal.	Per Cent of Services Metered
1. New York	139	26.0
2. Chicago	296	11.7
3. Philadelphia	165	30.0
4. Detroit	140	99.1
5. Cleveland	127	100.0
6. St. Louis	140	7.7
7. Boston	115	100.0
8. Baltimore	127	14.0
9. Los Angeles	119	99.0
10. Buffalo	208	16.2

Should they not be done away with, then the deficiency in the recommended plan thus caused would have to be made good by bringing water from Rondout Creek or Catskill Creek across the Hudson into the proposed aqueduct, which would entail much additional expense.

The accompanying map shows the several reservoirs. The largest of these, on Kinderhook Creek, has a storage capacity of 44,000 m.g. and would have a drainage area of 150 sq.mi., with a daily yield of 123 m.g.d.

The capacity of the proposed aqueduct would be 150 m.g.d. at Kinderhook Creek, increasing to about 600 m.g.d. immediately above the Kensico reservoir. Be-

tween this reservoir and the Hill View equalizing or distributing reservoir an aqueduct with a capacity of 750 m.g.d. is proposed "in order to provide for transporting the maximum draft during periods of peak consumption."

The second delivery tunnel to New York, recommended, as stated, in 1924, would be a deep pressure tunnel with a diameter of 17 ½ ft. and a length of 20.2 mi. from the Hill View reservoir in the city of Yonkers to South Brooklyn. This delivery tunnel would carry a portion of the present Catskill supply. The present delivery tunnel has been in use since 1915. Dependence upon it alone, even at present, Mr. Merriman considers as involving a serious risk.

Construction Program—The recommended stages of construction are: (1) The new delivery tunnel; (2) the aqueduct from Hill View to Kensico reservoir, and from Kensico reservoir to the Croton shed, together with the new reservoir on the east bank of the Croton River, the aqueduct from the Croton watershed to the Silvernails reservoir, and the reservoirs on the Fishkill and Wappinger and Roeliff Jansen; (3) the aqueduct from Silvernails to Kinderhook Creek and the reservoirs on the Kinderhook, Taghkanic, Stony, Kline and Claverack.

Aside from the new delivery tunnel, which should be built at once in any case, the report states, a construction program is submitted in the report which provides $2,000,000 and $6,000,000 for the first two years respectively, and then $15,000,000, $35,000,000 and $50,000,000 for the next three years respectively, and various sums for the remainder of a 15-year construction period.

SUMMARY OF ESTIMATES OF COST OF NEW WATER SUPPLY RECOMMENDED FOR NEW YORK CITY

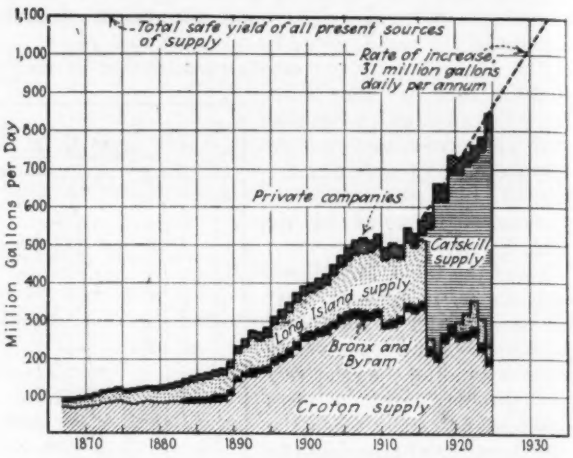
1. East Nassau reservoir	$23,094,000
2. Stony Kill reservoir including connection with Kline Kill reservoir	6,324,000
3. Kline Kill reservoir	9,866,000
4. Philmot reservoir	6,530,000
5. Taghkanic and New Forge reservoirs	13,442,000
6. Silvernails reservoir	40,578,000
7. Aqueduct East Nassau reservoir to Silvernails reservoir	33,319,000
8. Reservoirs on tributaries of Wappinger Creek	15,362,000
9. Sprout Creek reservoir	4,504,000
10. Jackson Creek reservoir	3,152,000
11. Beekman reservoir on Fishkill Creek	12,197,000
12. Patterson reservoir	11,416,000
13. Controlling works on East and West Branch of River and on Muscoot River and connections with main aqueduct	7,491,000
14. Aqueduct from Silvernails reservoir to Kensico reservoir	106,845,000
15. Gate houses, bypass aqueduct and control works at Kensico reservoir	8,494,000
16. Aqueduct Kensico reservoir to Hill View reservoir	43,049,000
17. Aerator and connections below Kensico reservoir	644,000
18. Gate house and bypass aqueduct and connections at Hill View reservoir	1,727,000
Total	$347,934,000

The aqueduct from East Nassau reservoir to Hill View reservoir is divided as follows:

	Miles
Tunnels on hydraulic gradient	53¼
Tunnels below hydraulic gradient	13⅜
Cut and cover aqueduct	57⅜
Reinforced concrete aqueducts	4⅜
Steel pipe siphons	2¾
Total length	132¼

Cost of the aqueduct from Hill View reservoir to the Croton watershed and the construction of the Patterson reservoir and other works by which to divert 133 m.g.d. of Croton water at higher levels	$104,966,000
Cost of development of the first additional supply of 204 m.g.d. from the Fishkill and Wappinger Creeks and the Roeliff Jansen Kill	150,393,000
Cost of development of the remainder of the supply from the Taghkanic and Claverack Creeks, the Kline and Stony Kills and the Kinderhook Creek	92,575,000
	$347,934,000

The accompanying table summarizes the cost estimates for the various elements of the project under 18



YEARLY INCREASE OF WATER DRAWN BY NEW YORK CITY FROM ITS VARIOUS SOURCES OF SUPPLY

heads and gives some figures regarding the aqueduct and also gives under three heads a statement of the cost of the $348,000,000 project.

Gasoline Taxes Reach $85,000,000 in Six Months

Taxes on gasoline used in motor vehicles amounted to $84,939,373 in the first six months of 1926, according to the U. S. Bureau of Public Roads. This amount was made available as follows: $54,981,677 to state highway departments, $19,338,976 for county and local roads, $6,329,413 for state and county road bonds, and $4,140,998 for miscellaneous purposes. A total of 3,560,987,586 gal. of gasoline was taxed and it is estimated that an additional 856,450,000 gal. was consumed in the four states in which taxes are not collected. All of the states except Illinois, Massachusetts, New Jersey and New York imposed a gasoline tax, the rate ranging from one to five cents with an average of 2.39c. per gallon. Since 19,697,832 motor vehicles were registered in the six months period, the gasoline consumption per vehicle averaged 225 gallons. Gasoline taxes were first imposed in 1919 when four states adopted the tax and derived a revenue of a little more than one million dollars; the practice has now spread to all the states but four.

The revenue derived from the gasoline tax in the first six months of 1926 by states was:

Alabama	$1,175,152	Nevada	$173,719
Arizona	456,334	New Hampshire	263,944
Arkansas	1,861,280	New Jersey	.....
California	7,413,624	New Mexico	332,536
Colorado	921,426	New York	.....
Connecticut	1,140,433	North Carolina	3,598,412
Delaware	173,214	North Dakota	339,507
Florida	6,197,421	Ohio	5,968,232
Georgia	2,559,217	Oklahoma	2,775,015
Idaho	477,123	Oregon	1,466,204
Illinois	.....	Pennsylvania	5,252,410
Indiana	4,022,264	Rhode Island	224,693
Iowa	2,193,634	South Carolina	2,454,033
Kansas	1,839,712	South Dakota	848,663
Kentucky	2,448,809	Tennessee	1,700,601
Louisiana	1,253,859	Texas	2,355,792
Maine	561,791	Utah	568,724
Maryland	1,019,388	Vermont	179,468
Massachusetts	.....	Virginia	2,446,643
Michigan	4,373,598	Washington	1,595,302
Minnesota	2,148,340	West Virginia	1,194,022
Mississippi	1,722,707	Wisconsin	2,189,579
Missouri	2,561,611	Wyoming	220,833
Montana	388,946	District of Columbia	478,217
Nebraska	1,402,941	Total	$84,939,373

Engineering Literature

A MONTHLY REVIEW OF BOOKS AND A LISTING OF NEW PUBLICATIONS

Sewage Disposal Today and Tomorrow

SOLVING SEWAGE PROBLEMS—By George W. Fuller, M. Am. Soc. C. E., M. Eng. Inst. Can., M. Inst. C. E., and James R. McClintock, M. Am. Soc. C. E., M. A.S.M.E. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6 x 9 in.; pp. 548; 83 halftones and line cuts. $6.

The decision to strike out on new lines instead of revising the senior author's "Sewage Disposal" is justified by the results shown in this book, which is aptly named "Solving Sewage Problems." Revision of a book on a rapidly advancing art or science is a difficult matter at best and generally leaves author, publisher and reader not wholly satisfied. The argument for a new book instead of a revision is strengthened when the effort is largely collaborative, as in the present case. The two authors who assume responsibility for the book give credit to five of the principal members of their staff besides acknowledgment of aid in the chapters on activated sludge from William R. Copeland, editing of the entire work by Abel Wolman as well as preparation of a number of chapters, and criticisms and suggestions by Langdon Pearse, Asa E. Phillips, F. W. Mohlman, J. K. Hoskins and others. Thus more than a dozen well-known engineers, chemists and biologists had a hand in producing what for some time to come promises to be the most thoroughgoing and up-to-date book on sewage disposal—a book confined almost wholly to the problems of today but forecasting those of tomorrow.

The volume deals almost wholly with methods now widely used or rapidly forging to the front, letting the reader go elsewhere for information on processes which have had their day. Chief attention is given to screening, sedimentation, sludge digestion, sprinkling or trickling filters, chlorination and the activated-sludge process. Contact beds and intermittent sand filters are not overlooked. Chemical precipitation is restricted to a couple of pages, with a clear understanding of the fact that this is no reflection on chemical processes to cope with some of the industrial wastes. Because of the lure of things electrical subject to the inventor and promoter, and also to make perfectly clear their limitations here, seven or eight pages are devoted to electrolytic processes and direct oxidation, which together have been the will o' the wisps of sewage treatment for nearly a half century.

The comprehensiveness of the book as a manual of current ideas and practice will be seen by the following synopsis of its contents: First the problems of sewage disposal in general are reviewed, then its legal, legislative, and administrative aspects. Next, the characteristics of sewage, and other basic design data are given. A group of chapters deal with the biochemistry of sewage, dilution, nuisance and hygienic aspects, natural purification of streams, oxygen balance and residual oxygen, and then plankton and biological balance. A look is then taken to lakes, oceans and tidal estuaries, ways and means of overcoming the limitations of disposal by dilution, and at collecting system factors.

After a baker's dozen of chapters, authors and readers alike are ready for a consideration of the various methods of sewage treatment, beginning with screens and going through the list of well-known methods which are either widely practiced today, or are important because now in demand to meet special conditions, or because they forge ahead to probable first space.

Emphasis and corresponding space are given to sedimentation and sludge digestion, and to the activated-sludge process. A return to plain sedimentation, but with separate sludge digestion, and great promise for the activated-sludge process are indicated. Utilization of sludge as a fertilizer or fertilizer base is given attention but it is made clear that there is a long way farther to go along this already long path before sludge utilization will be more than a small contribution to the reduction of the cost of sewage treatment, even if it repays the extra cost and trouble which utilization incurs, especially in the case of activated sludge. The authors do not deny—or hint any strong promise either—that there may be more rapid progress on this long path in the future than the past has shown.

A non-technical summary closes the body of the book. Of two appendices, one summarizes state and other governmental attempts to control water pollution and the other takes up the treatment of the phenol wastes that in some places are causing so much trouble from tastes and odors in public water supplies, especially chlorinated supplies.

The volume as a whole is a model of masterly condensation without sacrifice of clearness. Clear-cut separation of descriptions of processes from a consideration of the works to carry out the processes is a commendable feature and one that should make the book particularly useful to the lay official and others who are chiefly concerned with processes and what they may be expected to accomplish rather than with details of screen, tank or filter design. A book so well planned and executed and, considering the magnitude of the subject, brought within so small a compass, seems bound to prove useful to a large and varied class of readers. Every engineer, chemist and biologist concerned directly or indirectly with sewage disposal should welcome it warmly and recommend it as warmly to a wide circle of non-technical men and women interested in municipal problems and a reasonable policy of preserving our natural waters from pollution.

Photographic Surveying Methods

PHOTOGRAPHY: A Practical Manual of Photographic Surveying Methods—By Arthur Lovatt Higgins, M.Sc., A.R.C.S., A.M. Inst. C.E. Lecturer in Civil Engineering, East London College (University of London); Formerly assistant-lecturer in engineering in the Victoria University of Manchester, and assistant to the professor of civil engineering in the Queen's University of Belfast. Cambridge, England: The University Press. New York: The Macmillan Co. Cloth; 5x7 in.; pp. 127; 43 line cuts, 9 plates. $2.40.

Inasmuch as there is so little written material on the subject of photographic survey work this volume should reach a wide circulation. Let it be understood that it deals with ground work alone, no references being made to the uses of the camera for aerial work. The book is really a manual covering the practice of this type

of surveying. Full explanation of field methods and office computation, the latter going into formula derivations, is given. The author takes into account the rather limited range of utility which the system has and also the numerous sources of possible error inherent in phototopographic mapping. He recommends it as a method "because of its amenability to conditions under which other methods would fail or be inexpedient." For those who do not know how the camera, with its perspective eye, can assist, through iconometric reductions, in the production of land plan views, Mr. Higgins' book should be entertaining. For the engineer who wishes a manual on the subject it should prove very useful.

Structural Design of Pressure Conduits

REVIEWED BY I. GUTMANN

Research Engineer, Sanborn & Bogert, Consulting Engineers, New York City

DRUCKROHRLEITUNGEN: Berechnungs- und Konstruktions-Grundlagen der Rohrleitungen für Wasserkraft- und Wasserversorgungsanlagen—Von Dr.-Ing. Felix Bundschu, Oberingenieur im Ingenieurbüro und Dr.-Ing. Adolf Ludin, Berlin-Charlottenburg. Berlin: Julius Springer. Paper; 6 x 9 in.; pp. 60; illustrated. 6 reichmarks in Germany.

The structural design of pressure conduits of small diameter is a comparatively simple matter. The shell thickness which has to be provided for internal radial pressure is generally adequate for the great number of other stresses, some of which are very complex. But when we come to the design of conduits of large diameter these commonly ignored stresses (Arthur Kruschka enumerates about thirty varieties of these) become greatly magnified, requiring extra strength, and a detailed rational design becomes imperative.

The brochure by Doctor Bundschu is a brief up-to-date compendium of the principles and formulas underlying this class of design. The subject is treated in a very practical and condensed manner; the principles are stated very briefly, the formulas are not derived. Still, a reader interested in derivations and critical discussions, who may want to make a detailed study of any phase of the subject, is enabled to do so by the bibliographic list of 44 original references, mostly German, given at the end of the pamphlet. Thanks to this valuable feature this little book becomes an able introduction and guide to the extensive but very scattered literature on this branch of engineering.

The author is a senior engineer in the office of Doctor Adolph Ludin, who is one of the foremost German authorities on hydro-electric engineering, and his recommendations undoubtedly reflect sound, accepted German practice. One or two of his recommendations are at great variance with American practice and seem open to criticism.

Thus, on p. 18 a shell thickness equal to 1 per cent of the diameter is recommended for iron and steel pipes. (According to this recommendation the shell of the 10-ft. Antelope Valley siphon of the Los Angeles aqueduct which is ¼ to ½ in. thick should have been made 1.2 in. thick.) The thickness recommended would enable a pipe to withstand a 100 per cent internal vacuum with a factor of safety of four, independently of air valves. It is perhaps not unwise to make a pipe safe against collapse without relying on air valves, yet the recommended shell thickness must be considered excessive. A 100 per cent vacuum will not occur in practice for the same reason that the vacuum in the suction pipe of a pump hardly ever exceeds 60 per cent. Furthermore, the condition provided against is so rare and so extreme in intensity that a factor of safety less than four may be safely used. It appears that the shell thickness recommended is possibly three times in excess of practical requirements.

On pp. 17 and 18 it is stated that the backfill of a trench will exert uniform hydrostatic pressure on all the sides of a pipe buried in it. It is not evident whether this statement is a product of mechanical intuition or analysis. Recent elaborate tests by the Roadway Committee of the American Railway Engineering Association at Farina, Ill., have demonstrated that this is true only in the case of thin flexible pipes of corrugated iron and steel. It is not true of buried pipes made of stiff materials such as cast iron or concrete. In the case of these the earth pressures are very unevenly distributed and the pressure at the crown may be greater than the weight of the superimposed material.

Yearly Business Operations Since 1790

BUSINESS ANNALS: An Attempt to Summarize and Depict the Business Conditions in Seventeen Countries, Including the United States, by Years over an Extended Period in the Country's History—By Willard L. Thorp and Wesley C. Mitchell. New York: National Bureau of Economic Research, Inc. Cloth; 6x9 in.; pp. 380. $4.

No phase of business activities possesses more real interest to the executive and student of industrial operations than the recurring "ups" and "downs" of business and industry, commonly known as the "business cycle." If its probable duration and the accompanying degree of prosperity and depression could be foretold, much of the uncertainty would be taken out of business operations. The comprehensive study of this subject which has been made by Willard L. Thorp and commented on by Wesley C. Mitchell, both of National Bureau of Economic Research, is a most welcome contribution to the science of modern business.

"Business Annals" is an attempt to summarize and depict business conditions in seventeen countries as they appeared to intelligent and expert observers. The tables and yearly business and economic analyses run back through a considerable period, those pertaining to the United States and England extending back yearly to 1790. Each year of this extended period is summarized as to economic conditions—industrial, commercial, labor, money, security, foreign exchange, agricultural production and prices—and is also reviewed as to various non-economic phenomena which may have exerted an influence upon the conditions of business.

This record of business conditions has been made especially valuable and attractive to the general reader by Mr. Wesley's chapter of explanation and interpretation. Counting the business cycles as the intervals between recessions the author notes 32 business cycles in the United States in 127 years, which yields an average length of not quite four years. The commonest length is about three years; two-thirds of the cases fall within the limits of three to four years. There is no indication that the average duration of business cycles is changing. The analysis shows that American business cycles have the shortest average duration of all.

For those interested in the study of business and industrial trends, in the probable extent of the present period of prosperity, and the period of decreased industrial activity which must follow, this book will appeal. It is a valuable contribution to the science of business and industrial administration.

Non-Uniform Flows of Water Analyzed

REVIEWED BY E. W. SCHODER
Professor of Experimental Hydraulics, Cornell University, Ithaca, N. Y.

VON DER BEWEGUNG DES WASSERS, UND DEN DABEI AUFTRETENDEN KRAFTEN: Grundlagen zu einer praktischen Hydrodynamik fur Bauingenieure—Nach Arbeiten von Staatsrat Dr.-Ing. e.h. Alexander Koch, s. Zt. Professor an der Technischen Hochschule zu Darmstadt; herausgegeben von Dr.-Ing. e.h. Max Carstanjen. Nebst einer Auswahl von Versuchen Kochs in Sasserbau-Laboratorium de Darmstadter Technischen Hochschule zusammengestellt unter Mitwirkung von Studienrat Dipl.-Ing. L. Hainz. Berlin; Julius Springer; Cloth; 8 x 10 in.; pp. 228; 331 halftones and line cuts; 2 folding plates. Cloth, 28.5 reichmarks, in Germany.

The literature of hydraulics abounds in vigorous but mostly unfruitful comments on the great lack of sound theory and scientific methods of attacking practical problems. There is perhaps too much tendency forthwith to throw the whole burden on the experimenter to supply coefficients or to investigate and interpret the performance of small models.

The book under review represents a better type of response by an engineer, experimenter, and teacher who aimed to perfect the analytical technique of dealing intimately with stream lines and pressures in those cases of the flow of water involving transitions (non-uniform flows) that require more than the lump application of Bernoulli's theorem and the Chézy formula.

Koch made liberal use of experimentation on models, but chiefly to assist visualization, to establish the basic relations between cause and effect, and to furnish numerical checks so that his reasoning would approximate correct theory.

The first two-thirds of his book contains Carstanjen's selection from Koch's manuscripts, representing what Koch termed "Foundations for a Practical Hydrodynamics." The last third comprises data on experimental studies made in the hydraulic laboratory of the Darmstadt Technische Hochschule. This part is also a desired expansion of the very brief article on this laboratory and its work in "Die Wasserbaulaboratorien Europas" (reviewed in *Engineering News-Record*, May 20, 1926, p. 821).

Koch develops systematically and with great clearness numerous auxiliary equations and graphical methods used by him in handling the details of converging and diverging flows with their accompanying phenomena of curvilinear stream lines, accelerations positive and negative, pressures due to deviation, losses due to friction and impacts, etc.

Some of these auxiliaries are well known to young engineers but are commonly regarded as mainly pictorial or as of very limited applicability. For example, in most text-books the hydraulic and energy "grade lines" are only roughly sketched where changes in the flow occur, particularly for open channel conditions. Again, in estimates of river discharge from observed stages, the auxiliary use of stage-area and stage-velocity curves is commonly a lump proposition dealing with the whole cross-section of the stream. Koch makes a much more detailed use of these fundamentals in his arithmetic integrations. A few engineers in America have used analogous methods in treating the hydraulic jump.

The typically independent nature of Koch's studies is shown, for example, in his computations of the coefficients of contraction for flows through sluice gate openings. He attains his object with very little use of calculus, making basic assumptions reasonably true to nature. Probably only a few engineers know that the limiting 0.61 coefficient is formally derived by physicists in hydrodynamics. Koch's adaptations of the method will appeal more to engineers, and his success in this and other cases will establish confidence in his methods when used for phenomena less well understood.

Standing and traveling waves in open channels are given very clear elementary treatment. Considerable attention is given to sluice orifices (with and without adjutages), and some to overfall weirs.

Although there is not in all cases an experimental study corresponding to the theory, still the appendix discusses and pictures tests on transition flow in open channels, for example, jumps and swells; on contractions, for example, ground-sills, piers, submerged orifices, sudden closure of gate; and on discharge over various overfalls and through sluices and short-pipe adjutages.

In several cases the results of Koch's theoretical analyses were frankly stated by him to be quite unsatisfactory in view of the actual phenomena. Nevertheless there are enough good examples of proper theory to mark a distinct advance in this backward phase of hydraulics. Engineers will find the semi-graphic methods instructive.

Theory of Water Hammer

REVIEWED BY JOHN H. GREGORY
Consulting Engineer; Professor of Civil and Sanitary Engineering, The Johns Hopkins University, Baltimore, Md.

THEORY OF WATER HAMMER—By Lorenzo Allievi. Translated by Eugene E. Halmos. Printed in Rome, Italy. Paper; 7 x 11 in.; two volumes, 119 pp. of text in one, 44 plates in the other. Copies may be had free of charge from either the American Society of Civil Engineers or the American Society of Mechanical Engineers, 33 W. 39th St., New York City.

In this monograph, the original having been published in Italian in 1913, the author presents a highly mathematical and technical dissertation on the theory of water hammer. Preceding the monograph proper is an abstract, translated from the French, of an earlier paper by the author, 1902, on the general theory of the variable flow of water in pressure conduits which, the translator states, is needed for a proper understanding of the author's treatment of the subject. The monograph proper is divided into five chapters dealing respectively with a General Discussion of the Method, Water Hammer in Closure, The Water Hammer of Opening, Counter Blow During Return to Regimen and Phenomena of Resonance. The text is well printed and the cuts, which are published in a separate pamphlet, well executed; but as the wording used on the cuts is in Italian it is not easy for the reader to follow them unless he understands that language.

PUBLICATIONS RECEIVED

RELATED FIGURES for Cement in 1924, compile by E. F. Burchard and B. W. Bagley, of the Bureau of Mines, and published the latter part of August, 1926, are preceded by a section on 100 Years of Portland Cement. (5c. from Superintendent of Documents, Washington, D. C.)

STANDARDIZATION PROJECTS totaling more than 200, according to the 1926 Year Book of the American Engineering Standards Committee (29 West 39th St., New York City), "are in process or completed under the auspices of the A.E.S.C., and 365 national trade associations, technical societies and government bureaus" which are working in co-operation "through some 1,600 representatives."

SEWAGE-WORKS ENGINEERS will be interested in a paper entitled Observations on the Biological and Physical Properties of Activated Sludge and the Principles of Its Appli-

cation, by F. W. Harris, F.I.C., T. Cockburn, F.I.C., and T. Anderson, read in July at the conference of the Association of Managers of Sewage Disposal Works and reprinted by the Sewage Purification Department of Glasgow, Scotland.

TWENTY-FIVE PAGES of U. S. Public Health Reports (Washington, D. C.) for Oct. 1 are filled with an account of Experimental Studies of Water Purification, carried out at the stream pollution investigation laboratory of the Public Health Service of Cincinnati, Ohio. There is a description of the plant by Frederick J. Moss, assistant sanitary engineer, and a Preliminary Review of the Results of Primary Experiments, by H. W. Streeter, sanitary engineer, U. S. Public Health Service.

A NEW HIGH RECORD for the wood preserving industry in the United States was established in 1925, according to a statistical review of the subject by R. K. Helphenstine, Jr., published by the Office of Forest Products, Washington, D. C., under the title Quantity of Wood Treated and Preservatives Used in the United States in 1925. Reports from 167 plants (only 5 more than those in active operation the preceding year) show 275,000,000 cu.ft. treated or nearly 6,000,000 cu.ft. more than in 1924.

THERE IS NOW AVAILABLE on application, without charge, a Gazetteer of the Lakes, Ponds and Reservoirs of the State of New York, compiled by Edward M. Douglas, Map Information Office, Board of Surveys and Maps, of the Federal Government, Washington, D. C. Except for brief summaries in the way of text, the gazetteer consists wholly of a table giving the name of the pond or lake, its location by county, by quadrangle, by latitude and longitude; its area and its elevation. All told, 2,295 bodies of water are listed.

A COMPREHENSIVE REPORT on The Traffic Problem: A Study Made in Albany, N. Y., has been published jointly by the New York State Conference of Mayors and the Policyholders' Service Bureau of the Metropolitan Life Insurance Co., the office of the latter being at 1 Madison Ave., New York City. There are special sections on Street Accidents, One-Way Streets and Parking, Boulevard Stop Streets, Regulation of Pedestrian Traffic, and other subjects, and finally a summary giving a plan for the consideration of other cities than Albany.

ALTHOUGH the Texas Water Works Short School has had yearly meetings, now numbering 8, its various papers and discussions have been gathered in printed form for the first time to cover the proceedings of the school held at Fort Worth, Texas, January of this year. The proceedings run to 186 pp. and cover various phases of water supply, sewage disposal, and stream pollution. Some notable speakers from outside the state are included in the list of authors. (By mail, $1.35 in paper or $2.50 in cloth, from E. G. Eggert, Secretary, Texas Water Works Short School, State Department of Health, Austin, Texas.)

PAPERS ON RAILWAY SUBJECTS in the 1926 *Proceedings* of the American Railway Engineering Association include the following, which are in addition to the numerous committee reports: Economics of Railway Location and Operation, J. L. Campbell; Shrinkage of Earth, Swell of Rock and Shrinkage of Ballast, H. E. Hale; Water Softening on the Rock Island Lines, Paul M. LaBach; Relation between Swaying of Cars and Position of Rail Joints, B. R. Leffler; Effect of Minor Sags and Humps on the Operation of Trains, Walter Loring Webb; Design of Treads for Rolling Lift Bridges, O. E. Hovey. (E. H. Fritch, secretary, American Railway Engineering Association, 431 South Dearborn St., Chicago.)

CENTRIFUGAL PUMPS which are to be used primarily to handle oils of high viscosity should be designed for that work rather than as they would be for pumping water, is one of the conclusions of Robert L. Daugherty, professor of mechanical and hydraulic engineering, California Institute of Technology, in a report entitled "A Further Investigation of the Performance of Centrifugal Pumps in Pumping Oils." Professor Daugherty also concludes that the larger the pump the less it is affected by viscosity, but "in any event the head, capacity and efficiency must decrease, while the power required increases." The report, which extends to some 9 pp. of text and is accompanied by 13 plates of diagrams, was made to Goulds Pumps, Inc., Seneca Falls, N. Y., from whom copies may be obtained.

New Books and Revised Editions

[Those desiring copies of the books listed below or mentioned elsewhere in this section should order them from the publishers or from their local booksellers.]

APPRENTICESHIP: Information and Experiences in the Development of Industrial Training. Washington, D. C.: Department of Manufacture, Chamber of Commerce of the United States. Paper; 7x10 in.; pp. 51.

THE CAUSE AND PREVENTION OF EMBRITTLEMENT OF BOILER PLATE—By Samuel W. Parr, Professor of Applied Chemistry; and Frederick G. Straub, Special Research Assistant in Chemical Engineering. University of Illinois Engineering Experiment Station. [Engineering Experiment Station Bulletin, 155.] Urbana, Ill.; University of Illinois. Paper; 6x9 in.; pp. 62, 28 line cuts and halftones; 13 tables. 35c.

CONCRETE DESIGNERS' MANUAL: Tables and diagrams for the design of reinforced-concrete structures—By George A. Hool, S.B., Consulting Engineer, Professor of Structural Engineering, University of Wisconsin; and Charles S. Whitney, M.C.E., Consulting Engineer, Milwaukee, Wis. Second edition. New York and London: McGraw-Hill Book Co. Inc. Cloth; 6x9 in.; pp. 329; tables, diagrams and charts. $4.

DESIGN OF CONCRETE STRUCTURES—By Leonard Church Urquhart, C. E., Professor in charge of Structural Engineering, Cornell University; and Charles Edward O'Rourke, C.E., Assistant Professor of Structural Engineering, Cornell University. Second edition. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. 501; 184 line cuts. $4.

THE DETAILING OF SKEW PORTALS—By J. P. Davies. [Reprinted by permission from *Engineering News*. Feb. 11, 1909.] Ambridge, Pa.: J. E. Banks. Paper; 5x7 in.; 9 line cuts, pp. 20. $1.

DETERIORATION OF STRUCTURES OF TIMBER, METAL AND CONCRETE EXPOSED TO THE ACTION OF SEA-WATER: Sixth (interim) Report of the Committee of the Institution of Civil Engineers—Edited by P. M. Crosthwaite, B.A.I., M.Inst.C.E., Secretary to the Committee; and Gilbert R. Redgrave, Assoc. Inst. C. E. London: His Majesty's Stationary Office. Paper; 6x9 in.; pp. 40; with line cuts and tables. 2½ shillings.

DIESEL ENGINES: Marine, Locomotive, Stationary: A Practical Treatise on the Principle, Construction, Operation and Maintenance of the Diesel Oil Engine, both Marine and Stationary Types, with a Descriptive Chapter on the Latest Developments in Diesel Locomotives and Diesel Electric Drive for Ship Propulsion—By David Louis Jones, Commissioned Chief Machinist, U. S. Navy; Instructor, Diesel Engine Department, U. S. Navy Submarine School. New York: Norman W. Henley Publishing Co. Cloth; 6x9 in.; pp. 565; 241 engravings. $5.

Written to give the "practical operating engineer the elementary principles, care and operation of the Diesel Engine." Besides chapters on elementary thermodynamics and other principles, there is one on comparative efficiencies of this and other types, and a series of chapters on details of the Diesel engine and its operation, a chapter on types and makes of Diesel engines, one on lubricating oils and chapters on engines for railroad and naval service.

LABORATORY MANUAL OF TESTING MATERIALS—By William Kendrick Hatt, C.E., Ph.D., M.Am.Soc.C.E.; Professor of Civil Engineering and Director of Laboratory for Testing Materials, Purdue University; and H. H. Scofield, M.E., Professor of Civil Engineering in charge of Testing Materials, College of Civil Engineering, Cornell University. Third edition. New York and London: McGraw-Hill Book Co., Inc. Cloth; 5x7 in.; pp. 182; linecuts and tables. $2.

Recent changes in methods are reflected and in some cases the emphasis is shifted in the edition. The assistance of Prof. R. B. Crepps, Purdue University, is acknowledged. The first edition was noted in *Engineering News*, October 16, 1913, p. 788.

INDUSTRIAL SAFETY ORGANIZATION FOR EXECUTIVE AND ENGINEER—By Lewis A. DeBlois, S.B., director, safety division, National Bureau of Casualty and Surety Underwriters. Past President, National Safety Council. Member, Committee on Safety and Production, American Engineering Council. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. 328; 17 plates, 12 line cuts. $4.

LAND PLANNING IN THE UNITED STATES FOR THE CITY, STATE AND NATION—By Harlean James, A.B., Secretary of the American Civic Association and the Federated Societies of Planning and Parks. Preface by Richard T. Ely, LL.D., Professor of Economics in Northwestern University. Introduction by Albert Shaw, LL.D. New York: The Macmillan Co. Cloth; 5x8 in.; pp. 427; 50 line cuts and halftones. $5.

LEHRBUCH DER EISENHÜTTENKUNDE: Verfasst fur den Unterricht, den Betrieb und das Entwerfen von Eisenhüttenanlagen—Von Dr. Ing. E. H. Bernhard Osann, ord. professor an der Bergakademie in Clausthal Geheimer Bergrat. Zweiter Band: Erzeugung und Eigenschaften des Schmiedbaren Eisen. Zweite, neubearbeitete und erweiterte auflage. Leipzig: Wilhelm Engelmann. Cloth; 7x9 in.; pp. 866; 650 line cuts, 11 plates. 32 reichmarks, in Germany.

PROPERTIES AND MANUFACTURE OF CONCRETE BUILDING UNITS—Circular of the U. S. Bureau of Standards, No. 304. Washington, D. C.: Government Printing Office. Paper; 7x10 in.; pp. 41; 8 halftones. 20c.

TIDES AND CURRENTS IN DELAWARE BAY AND RIVER—By L. M. Zeskind, Lieutenant, (j.g.), U. S. Coast & Geodetic Survey, and E. A. Le Lacheur, Assistant Mathematician, U. S. Coast & Geodetic Survey. Paper; 6x9 in.; pp. 122; 40 linecuts, 55 tables. 25c. from Superintendent of Documents, Washington, D. C.

WASSERKRAFT-JAHRBUCH 1925-26—Von Oberbaudirektor K. Dantscher, ord. Professor, München, und Ing. Carl Reindl, München: Richard Pflaum. Cloth; 6x9 in.; pp. 382; 168 halftones and linecuts, 7 plates. 16 Reichmarks, cloth, in Germany.

Letters to the Editor

A FORUM FOR DISCUSSION OF VIEWS OF ENGINEERS AND CONTRACTORS

A Double Y-Track in Russia

Sir—In your *Engineering News-Record* of June 10, 1926, p. 950, I have read a very interesting note concerning the double Y-track for turning locomotives at the Brenner station on the Italian-Austrian frontier. It may be interesting for you to know that such a double Y-track for turning locomotives was built in 1910 at the Kiew station of the Russian Southwestern Ry., according to the design of Engineer Wischinsky. A general view of this track you will find in the accompanying photograph.

M. PRAVOSUDOVITCH,
President of the Technical Scientific Committee of Peoples Commissariat Means of Communications.

Moscow, Russia,
Aug. 18, 1926.

Economics of the Barge Canal

Sir—The following comments are offered to clarify the situation as to several points raised by the editorial in *Engineering News-Record*, Sept. 9, 1926, in the article by the writer entitled "Does the New York State Barge Canal Pay?," which appeared in the same issue.

It could hardly be urged that, if a single shipper in the state of New York saves a certain amount of money, the state itself would be justified in spending that much money to effect the saving. Although the individual instances of savings cited in the article are the only ones in which both tonnages and savings were clearly defined, they are only a few of many cases brought to the attention of the Barge Canal Survey Commission. Had the commission given attention to nothing else, undoubtedly hundreds of instances, possibly thousands, could have been adduced. The number of such cases shows that the savings are not confined to a few shippers, but are availed of by many. While the economies in transportation charges effected by the Barge Canal were represented as accruing to shippers, in one way or another some of the savings are inevitably passed on to others with whom they deal. Furthermore, in public improvements like this the only way in which the community can be benefited is through the individual; in this general case the community as such ships no freight. The practice of recommending public appropriations for river improvement projects intended to effect specific savings to individuals in lieu of the general public is the one used by the army engineers. Few if any public appropriations of any nature would or could be made if the benefit had to accrue directly to the public as an entity or, indeed, to each and every individual comprising it. It is brought out farther on that the total saving to the community, as represented by shippers, is likely to be considerably greater than total expenditures by the state.

Except as to rates on grain, no direct allusion was made to railroads in the previous article: too many people see red when railroads and canals are mentioned in the same breath. The savings cited were all effected by use of the Barge Canal as contrasted with the next least expensive route, whatever that was. The year 1925 was a fairly prosperous year for canal carriers; therefore, while not enough figures were brought out by the commission to derive transportation costs, it is undoubtedly true that the average rate-cost ratio was greater than unity by canal just as it also was by rail in the territory affected. While data in hand are not sufficient to compare real costs by the two methods of transportation, it is believed that the method of comparing rates instead of costs is essentially sound. To the consumer, that is, the shipper, rates indeed are costs.

If the Barge Canal were classified in one of the newer branches of engineering where changes in practice are rapid and frequent, such as sewage disposal, early obsolescence might be a serious danger. It occupies a place, however, in one of the oldest and most stable branches, where underlying principles have been well known to the profession for decades, many of them for centuries. The Barge Canal suffers little danger of becoming obsolete through being superseded by some other form of transportation, in the way trolley systems are being so largely superseded by buses. The motor truck has already become established as a carrier of freight, and even the airplane now looms in the field, but the evidence thus far presented shows the former to be limited to the relatively short haul and the latter to commodities of high specific value. Transportation agencies of these sorts are not likely to become highly competitive factors in the chief field of canal usefulness which comprises the medium to long haul and the medium to low specific value. The million dollars a year estimated for permanent betterments (and for the few remaining claims) is more than ample to effect replacements as well as betterments. The Barge Canal should be a useful transportation agency, in good working order, for many years beyond 1960.

In balancing total costs of the Barge Canal with total savings to shippers over a term of years, it should be permissible to use the figures certified by the comptroller to the legislature as proper for the canal debt charge, which includes both amortization and interest. Anything wrong with the method used by the comptroller would have made good campaign material in some one or more of the five or six changes of administration which have occurred since the passage of the original Barge Canal act. The average canal bond has a term of somewhat less than 50 years and matures before 1960. Using the unit figures quoted in the previous article, the total capital charge for the entire 50-year period assumed amounts in round figures to $308,000,000 from which, as pointed out in the editorial, may be deducted $25,000,000 for such interest and premiums as accrued during the construction period. About $22,000,000 of the cost was carried by direct appropriations, of which, incidentally, about $4,000,000 came from the sale of abandoned canal lands. This sum has been amortized and carries no interest. Maintenance and operation from 1918 to 1959 inclusive may be set down as $125,000,000. Permanent betterments and claims (starting only with 1926 because previous items of this nature may be considered to be included in the $22,000,000 appropriated directly) are estimated to be $37,000,000. A deduction of $15,000,000 for incidental income from 1918 to 1959 inclusive should also be made. Summarizing these items, they appear as follows:

Capital charge	$308,000,000
Direct appropriations	22,000,000
Maintenance and operation	125,000,000
Permanent betterments and claims	37,000,000
Gross expense	$492,000,000
Less interest and premiums	25,000,000
Less incidental receipts	15,000,000
Net expense	$452,000,000

Savings on freight transported in the same period, applying the unit saving previously deduced to actual tonnage carried through 1925 and to tonnage estimated to increase 10 per cent per annum progressively after that year, amount roughly to $504,000,000, an excess of $52,000,000 over expense. An end-to-end curve of tonnage from 1918 to 1925, which is fully sustained by using also the intermediate annual points, shows the progressive increase to have been about 10.65 per cent. Applying this figure for tonnage after 1925, the gross savings would be some $521,000,000 and the excess savings over expense $69,000,000,

giving a margin of $17,000,000. Annual savings being $23,000,000 in and after 1948, and net annual expense being $10,000,000, it is apparent that total savings at the 10 per cent rate should overtake total expense 4 years before 1960, say at the beginning of 1956. From 1956 to 1959, inclusive, net savings should be $13,000,000 a year and after then $20,000,000.

Far from being doubtful, the figure of 20,000,000 tons, which was used in the former article as the nominal annual capacity of the Barge Canal, is probably an underestimate. The water supply and the lockage capacity have been reliably estimated in terms involving much greater traffic capacity. Undoubtedly, as traffic increases, points will be found where congestion becomes acute. The item of more than $1,000,000 per annum for permanent betterments and claims is retained until 1960 in the above estimate to relieve such situations as they occur. The Oswego and Cayuga-Seneca divisions branch from the Erie division in such a way that the capacity of the Erie division is nearly the measure of the total capacity of all three. The Champlain division, on the other hand, is virtually a system by itself. It uses none of the impounded waters of the Erie division and likewise none of its locks except the oversize federal lock at Troy. The Hudson River, common to both divisions below Waterford, is much wider and deeper than minimum canal sections and can readily handle the maximum traffic of both divisions. Champlain division tonnage would therefore be entirely in addition to and beyond the nominal 20,000,000 tons ascribed to the Erie division. Traffic on the Champlain division for the past eight years has averaged 27 per cent of that on the other divisions and, when the remainder of the system is carrying 20,000,000 tons annually, may therefore be expected to approximate 5,000,000 tons a year.

The Barge Canal has been in operation long enough to determine approximately the initial and annual costs, the rate of traffic growth, and the savings effected on shipments. Weighing these and comparing them, the economic soundness of the project becomes apparent, aside from considerations as to its indirect value.

New York City, Sept. 18, 126. MAURICE W. WILLIAMS, Consulting Engineer.

[It was expressly stated in the editorial in question that the figures were "rough." A difference of a hundred million dollars for instance, can readily be made merely by changing the assumed annual increase of traffic for the next thirty or forty years. The fact remains that even by the best of figuring it will be 1956 before theoretical profits begin to accrue—or 55 years after the bonds were voted. —EDITOR.]

Velocity Head Changes a Factor in Flood Discharge Estimations

Sir—After reading the very interesting article entitled "Hydraulic Data on Rapidly Rising Floods in Small Streams" by D. J. F. Calkins in your issue of Sept. 9, p. 416, it occurs to me that it may be of interest to call attention to another method of estimating the flood discharge.

Such data as are contained in this article are of great value to the practicing engineer because of the paucity of such information. It should be remembered, however, that calculations of brief flood discharges are usually subject to a large element of uncertainty. In the case described, apparently no allowance was made for the change in velocity head between the upper section and the lower section. According to the data given, the area of the upper cross-section was 786.6 sq.ft. and the area of the lower section 593.0 sq.ft. This shows that the velocity of the water was very much accelerated while traveling between the upper and lower sections. When velocities are high, the changes in velocity head are unusually great. In this case, of the total head or drop between the upper section and the lower section, about one-half was required for the change in velocity head.

To solve the problem, making allowance for the change in velocity head, probably as convenient a method as any is to solve by trial. The total head between the upper and lower sections is approximately 14 ft. By trial, it may be found that, using a value of $n = 0.03$, a velocity at the upper section of 23.2 ft. per second and a velocity at the lower section of 30.8 ft. per second with a corresponding discharge of about 18,500 sec.-ft. there will be required a head of 7.6 ft. to overcome friction and 6.4 ft. to produce the increase in velocity head, thus consuming the total available head of 14 ft. By this method of calculation, then, the discharge would have been only about 18,500 sec.-ft. as compared with the 25,000 sec.-ft. calculated by Mr. Calkins.

In similar fashion, if $n = 0.04$, it may be found that of the total head of 14 ft., 9.5 will be necessary to overcome friction while 4.5 is necessary to produce the change in velocity head. The corresponding velocities are found to be 19.5 ft. per second at the upper section and 25.9 ft. per second at the lower section with a discharge of about 15,500 sec.-ft.

These figures serve to indicate the difficulties inherent in this computation. With our best efforts, there will still be a considerable degree of uncertainty attached to the results obtained but I am inclined to think that with such a case as the one described above the method of taking into account the changes in velocity head is the best one to use. In this case, it reduces materially the estimated maximum rate of the runoff.

Iowa City, Ia., Sept. 30, 1926. SHERMAN M. WOODWARD, Dept. of Mechanics and Hydraulics, University of Iowa.

St. Paul Has Changed Street Paving Benefit Assessment Plan

Sir—The editorial comment in *Engineering News-Record* for Sept. 16, "Street Benefit Assessments," prompts me to state that in recognition of the inconsistency of the prevailing method of assessing street paving, St. Paul so amended its charter in 1923 that not to exceed 12 ft. of paving can be assessed on the abutting owners. Twelve feet was arrived at on the theory that 24 ft. was sufficient roadway to give easy access to one's home or business, your neighbor across the street and your neighbor in the next block (three lanes, two parked and one moving), and if any additional width of roadway is necessary it is due to through traffic and should be paid for by the city at large. This makes it possible for the city to pay the entire cost of paving on arterial highways, but where a residence street is paved purely for the benefit of the abutting property to 24 ft. then the abutting property pays for it. Between these two extremes there may be a graduation according to benefits.

I believe that Richmond, Va., and Providence, R. I., have always paid for paving out of municipal funds, while San Francisco has a district fund from which the paving in that district is paid, thus recognizing that streets and roads are public utilities. There may be others.

St. Paul, Minn., Sept. 21, 1926. GEORGE H. HERROLD, City Plan Engineer.

Narrow Lanes Cause Pavement Wear

Sir—R. H. Simpson, city engineer of Columbus, Ohio, should be commended for placing before those interested in road building and maintenance the results of his observations and conclusions as to pavement wear in the article on p. 551 of *Engineering News-Record*, Sept. 30, 1926.

This proves what I have been observing on some of our hard surfaced types of streets in Cincinnati, where traffic is confined continually to narrow lanes because of conditions described in this article.

I have in mind particularly Central Ave., from Third to Fourth Sts., in Cincinnati, which was resurfaced with granite blocks about five year ago, and which I have noticed is beginning to show the effects of vehicular traffic moving within the confines of a small area of the roadway and the resulting abrading of the surface by this continuous traffic.

I believe, if a survey of traffic wear were made on this street like the test made in Columbus, that the same conditions would obtain, perhaps not so appreciably as in the brick street, but the result would prove the conclusions drawn from the Columbus survey.

Cincinnati, Ohio. Oct. 5, 1926. W. H. LUKEN, Granite Paving Blocks.

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

Subway Contractors Fight Wage Arbitration

Contract Forms for New York Subway Would Maintain Prevailing Wage—Temporary Injunction Obtained

An attempt by the Board of Transportation of the city of New York to require contractors on the subway work under construction in the city to pay "prevailing rates" of wage and to submit to arbitration of any wage dispute is being fought by the contractors. A temporary injunction was served on Oct. 11 against the members of the Board of Transportation and of the Board of Estimate and Apportionment, requiring them to show cause why they should not be enjoined "from taking any action in regard to the awarding of contracts for the construction of the 53rd St. route of the city's new subway system from Eighth Avenue to Second Avenue," bids for which were received that day. The order to show cause was issued on a taxpayer's petition, but the issue is being fought by the local contractors. The matter was to be argued on Oct. 20. At the time of going to press no decision has been handed out by the presiding judge.

ESSENCE OF CONTROVERSY

The controversy hinges on two clauses in the contract for this section of the subway, clauses which were not included in the contracts which are being carried out on the remainder of the subway system. The points of issue in these clauses are the requirements by the city; (1) "that the wages to be paid upon the work contemplated shall not be less than the prevailing wage for a day's work in the same trade or occupation in the locality within the state" and the further provision of the city that for the purposes of this contract "the locality within the state shall be understood to be the city of New York as existing at the time this contract is delivered," and, (2) "that the arbitration law of the State of New York shall be invoked in case of any controversy as to wages."

The elaboration of these two clauses as they appear in the final contract was added after the public hearing, which by law is required to precede the advertisement for bids under such a contract. There is a protracted explanation of what is meant by the "prevailing rate of wage," which reads:

"It is further so understood and agreed between the parties to this contract that the 'prevailing rate' of wage shall be that rate paid to a majority of the laborers, workmen or mechanics, engaged in the same trade or occupation in the city of New York. In the event that there is not a majority in the same trade or occupation in the city of New York paid at the same rate, then the rate paid to the greater number of such trade or occupation in the city of New York shall be the prevailing rate, provided that such greater number constitute at least forty per centum of the laborers, workmen or mechanics engaged in such trade or occupation in the city of New York; in the event there is less than forty per centum of the laborers, workmen or mechanics engaged in the same trade or occupation in the city of New York paid the same rate, then the average rate paid to such laborers, workmen or mechanics in the same trade or occupation shall be the prevailing rate. For the purpose of determining the number of laborers, workmen or mechanics engaged in any such trade

(*Continued on p. 681*)

Engineering Fifty Years Ago

From *Engineering News*, Oct. 21, 1876

THE bridge of the Boston Water Works over the Charles River is supported by the largest arch, except one, in the world. It measures 134 ft. in length, and 65 ft. from the keystone to the water. The weight at the center is 480 lb. to the square inch. It was constructed solely to carry the Sudbury River to the other side, and will cost, when completed, $200,000.

N. Y. Central to Control Hudson River Connecting R.R.

Authority has been granted the New York Central R.R. by the Interstate Commerce Commission to acquire control of the railroad property, franchises and facilities of the Hudson River Connecting Railroad Corporation. The terms of acquisition are in the form of a one-year lease which is renewable for a period of 99 years. The property may not be subleased, disposed of or abandoned.

Erie Technical Men Unite

Approximately 400 technical men of Erie, Pa., recently organized the Technical Federation of Erie. The organization is the result of several years' agitation among engineers and allied professions for a closer association. Quarters for a club room and library have been secured at the Erie Chamber of Commerce.

Officers for the coming year are: Chairman, C. Paxton Cody, architect and recently elected president of the Pennsylvania State Association of Architects; vice-chairman, J. Frederick Wadsworth, consulting engineer; treasurer, W. H. Pelton of the Erie Lighting Co., and secretary, M. W. Ward of the American Sterilizer Co.

I.C.C. Approves Lackawanna Extension in Jersey City

To Connect Present Hoboken Freight Terminal with New Facilities Near Holland Tunnel Portal

The Delaware, Lackawanna & Western R.R. was authorized by the Interstate Commerce Commission on Oct. 15 to construct a four-track branch line in Jersey City at an estimated cost of $2,120,000. This represents the first step in the railroad's plan to construct additional freight facilities in New York Harbor at an estimated cost of about $13,000,000. The site of the proposed trackage and freight depot comprises an area equivalent to about nine city blocks in Jersey City. It is a short distance west of the Lackawanna freight depot and south of the main tracks and conveniently located with respect to the Jersey City portals of the Holland Vehicular Tunnel. Much of the freight now carried on floats will be transferred from Manhattan to Jersey City by truck when this tunnel is opened and the terminal is planned to expedite this movement with least congestion in Jersey City.

PROPOSE ELEVATED TRACKS

Definite plans as to the details of the depot and trackage are not yet in final form, but it is understood that the new line will be carried for the most part on steel viaducts passing over the lines of the New Jersey junction and the Erie Railroad companies. The line will be about 0.7 miles long and will extend from the connection with the main tracks of the Hoboken terminal over fills and flat-slab concrete construction to the steel viaduct over the freight yard.

Work on the proposed freight station which makes up about 50 per cent of the $13,000,000 project is scheduled to begin Jan. 1, 1927, and to be completed Dec. 31, 1928. Construction of the branch line will begin at the same time but will require only about a year to complete.

Iowa Water-Works Men to Meet at St. Louis

With a view to attracting Missouri members, the Iowa Section of the American Water Works Association will hold its twelfth annual meeting at the Statler Hotel, St. Louis, Mo., on Nov. 3 to 5. It is planned to devote the first two days to papers and round-table discussions, except that the second evening will be turned over to the manufacturers' representatives. On Nov. 5 there will be excursions to the Chain of Rocks and Mississippi River plants of the St. Louis water works. Homer V. Knouse, Omaha, Neb., is chairman of the Iowa section, and the secretary is Jack J. Hinman, Jr., University of Iowa, Iowa City, Iowa.

Pensacola Naval Station Damaged $1,000,000

Sept. 20 Hurricane Effect Report Is Issued by Navy Department—Rebuilding Under Way

Pending a final estimate of the damage at the Naval Air Station, Pensacola, resulting from the hurricane of Sept. 20, the personnel of the station is clearing away wreckage and making temporary repairs with funds available so as to continue the training of aviators, says a press release issued by the Navy Department.

Of the 230 planes at the air station, 47 were destroyed as a result of the hurricane; of these 38 were damaged beyond economical repair, and nine have been subsequently burned in order to eliminate fire hazard. Most of the 38 planes seriously damaged were of an obsolescent type originally built during the World War.

The Bureau of Yards and Docks, Navy Department, has sent Lieut.-Commander R. H. Gifford, C.E.C., U.S.N., to Pensacola to complete the estimate of appropriations necessary to restore public works. A brief report of the principal storm damage to public works has been filed in the Department by the commandant of the air station. This report lists eight buildings completely destroyed; runways on the east and southeast, part of the station rendered inaccessible; all paving, railway tracks and seventy-five per cent of the fill at piers 302, 303, and 178 washed out; and damage of major character to roofs, windows, doors and sidings. The total area suffering serious damage amounts to about 25 per cent of the entire station.

High Tide Disastrous

This report indicates that although the wind reached a velocity in excess of 128 miles an hour, the great bulk of serious injuries which the station sustained was due to the fact that the water reached a height of 8.54 ft. above mean high tide, and that it carried much wreckage which was propelled with violence against buildings. The Bayou Grande bridge was temporarily put out of commission by the rise of water which lifted the decking from it, washing the decking away about 250 ft. at each end. None of the piles of the bridge, nor the deck for about 800 ft. in the center, was injured. A temporary bridge and water line across it were completed five days after the hurricane. Water, sewerage and cold storage were first maintained by tractor, and lighting by connecting a motor boat engine to one of the station's generators. Normal service was restored within six days. No serious injury to personnel occurred.

An estimate sent to the Navy Department by the commandant immediately after the disaster stated that not less than $1,000,000 was necessary to restore public works to former condition of usefulness and not less than double that amount to make the station reasonably secure against similar damage, including a suitable bridge for communication and to preclude another cutting off of the water supply.

The storm of Sept. 20 was the most severe that has ever occurred in the vicinity of Pensacola, with a wind velocity of 128 miles an hour, and a barometer reading of 28.56 in. The records of severe storms which have been sent to the Navy from Pensacola show three previous to the one of this year which have caused any material damage. On Sept. 26, 1906, a hurricane and tidal wave swept what was then the navy yard, the water rising to 9.3 ft. above mean high water level. The damage to the navy yard was heavy, amounting to $220,000. Congress appropriated $200,000 to replace damaged structures.

A violent storm visited Pensacola on July 5, 1916, a little over two years after a naval air station had been established. The wind velocity recorded was 104 miles an hour, and barometer reading 29.37 in. The water rose over 4 ft. above normal high tide level, and surf, wind and rain did serious damage to station property, the greatest damage being to wharves. It was recommended that reinforced-concrete wharves be built to replace the pile wharves wrecked, and that all electric lines be placed underground. These two recommendations were carried out under an appropriation amounting to $198,000 out of a total of $420,000 specifically appropriated by Congress for reconstruction purposes.

The third serious storm previous to the one of this year occurred during wartime, while the air station was turning out classes in large numbers. Wind velocity was recorded up to 103 miles an hour, with a rise of water above normal high tide of 6 ft. The cost of restoring runways, temporary hangars, and bulkheads brought the total cost of repairs to $76,000.

Offers to Produce 150 M.G.D. of Well Water for New York

An offer to furnish New York City with 150 m.g.d. of water from driven wells on Long Island has been made to the Board of Estimate and Apportionment by the Titus Water Engineering Corporation, New York City, and has been referred by the board for investigation and report to its chief engineer, Arthur S. Tuttle and to the Department of Water Supply, Gas & Electricity, of which William W. Brush is acting chief engineer in the absence of the chief engineer, Merritt H. Smith, who is ill. The corporation named proposes that its compensation be dependent upon the amount of water actually developed.

A somewhat similar proposal from the same concern was made to the Board of Estimate in 1923, but has never been acted upon. The outcome of the investigation and report of the two engineers named will be of all the more interest because the proposal for a well supply preceded shortly the submission to the Board of Estimate of a plan for an additional supply of 434 m.g.d. from streams east of the Hudson submitted to the board by the Board of Water Supply of the City of New York under whom the additional supply from the Catskill was developed. An abstract of this report will be found on p. 670 of this issue.

A.S.M.I. Announces Program for Nov. 8-12 Meeting

Joint Session on Nov. 11 with Asphalt Association Scheduled—Wide Range of Discussion Covered

A wide range of subjects and a joint meeting with the Asphalt Association are features of the annual convention of the American Society for Municipal Improvements which is to be held in Washington, D. C., Nov. 8-12.

On Monday afternoon, Nov. 8, committee meetings will be held. The formal opening of the convention will take place in the evening of the same day. At the Tuesday morning session committee reports on street paving and design, street maintenance, street cleaning and snow removal, street and traffic lighting and public safety will be interspersed with papers on recent development in design of cement-concrete pavement and pavement bases, tests of brick pavement, the theory and practice of asphalt pavement, maintenance data of roads in Cuyahoga County, Ohio, municipal engineering in the tropics, further experiments on the durability of concrete in sea water, the importance of care in mechanical handling of bituminous materials for penetration-macadam and surface treatments, rock asphalt and its place among paving materials of today, and suggested organization of the engineering departments in small cities.

Committee Reports

In the Tuesday afternoon session, reports will be made by specification committees and representatives of the society and other organizations such as American Society for Testing Materials, National Research Council, Department of Commerce, American Engineering Council and American Engineering Standards Committee.

The morning session on Wednesday, Nov. 10, will be devoted to city planning, public welfare and recreational subjects. At the Wednesday afternoon session, sanitary papers and reports will be given and discussed.

At the Thursday morning session, which is also a joint session with the Asphalt Association, the principal papers will be on the construction details essential to effective hot-mix pavements, black base and its place in standard specifications and the economics of salvaging old pavements.

Oklahoma City to Vote on City Manager Plan Nov. 2

A proposed council-manager plan of city government will be voted on at Oklahoma City on Nov. 2. The plan includes a council of 8, apparently elected at large, and a mayor to serve as the ninth member and to be designated chief executive officer of the city. The manager would be called chief administrative officer and would prepare the city budget. Opponents to this plan have filed petitions for three other plans to be voted on, all characterized as intended to confuse the issue and one at least to nullify the powers of the manager by making them subject to approval by the council.

Colorado Compact Causes Extra California Legislative Session

A special session of the California legislature has been called for Oct. 22 for the express purpose of taking action on the six-state Colorado River compact, which compact has already been unconditionally ratified by Nevada, Utah, Colorado, Wyoming and New Mexico.

A seven-state compact was ratified in 1923 by the six states named, only the seventh state, Arizona, declining to ratify. The matter came up again before the 1925 session of the California legislature as a six-state compact, Arizona this time being omitted. At that session the compact was ratified by the California legislature conditionally, that is, provided Congress voted funds for a 20,000,000 acre-ft. reservoir in Boulder Canyon. This reservation had the effect of practically rejecting the compact so far as California was concerned. In calling the present extra session of the California legislature Governor Richardson announced that he did so in the hope that the six-state compact can now be unconditionally ratified, thus paving the way for ratification by Congress when it meets for the short session beginning the first week in December. The Swing-Johnson bill requires ratification by the six states before Congress acts on it.

Subway Contractors Fight Wage Arbitration

(*Continued from p. 679*)

or occupation, all the laborers, workmen or mechanics engaged in the performance of work under this contract and all other laborers, workmen or mechanics in the city of New York engaged on similar work to that required under this contract, whether rapid transit railroad construction or otherwise, shall be included in such total number."

The arbitration clause requires the contractor or the board to arbitrate "any controversy arising between the parties hereto growing out of the provisions" of the prevailing wage clause. It does not require arbitration of any other dispute between the contractor and the board, but it makes it obligatory on the contractor to accept any wage decision that the arbitration board lays down.

The contention of the contractors is that the "prevailing rate of wages" clause is in violation of the 14th Amendment of the Constitution, and that the arbitration requirement is invalid for the reason that a wage controversy is not a controversy within the meaning of the arbitration law in the State of New York.

The contractors further contend that the two added clauses to the contract will mean millions of dollars extra cost to the city of New York in the building of its subways, inasmuch as no bidder can closely estimate the labor cost of any work if at some future time that labor cost is to be affected by the decisions of an arbitration board. In consequence, the contractors contend, any bidder will have to make wide allowance in his bid for the possibilities of such arbitration decisions.

State Engineer of Wyoming Runs As Candidate for Governor

It is of interest to the engineering profession that Frank C. Emerson, for the past six years state engineer of Wyoming, has been nominated for governor. Mr. Emerson was born at Saginaw, Mich., May 26, 1882, and was graduated from the school of civil engineering, Michigan University, in 1904.

He went to Wyoming in 1904 soon after graduating and has been actively engaged in engineering and construction work in that state ever since. In 1905 he had charge of the location for the state of two large canals proposed for the reclamation of the ceded portions of the Shoshone Indian Reservation, one of which is now under construction by the U. S. Bureau of Reclamation to serve the Riverton Project. Following this, in 1907, Mr. Emerson was chief engineer of Wyoming Land & Irrigation Co., which position he held until 1915, when he became superintendent of the Big Horn Canal Association and Lower Hanover Canal Association, and engineer for the Worland Drainage District and for the Wyoming Sugar Co. In addition to this work, he maintained a general consulting practice at Basin, Wyoming. On July 1, 1919, he became state engineer. As such he is, ex-officio, president of the State Board of Control.

In April, 1921, Governor Carey reappointed Mr. Emerson for a six-year term but the succeeding governor refused to confirm the appointment and attempted to remove him from office by summarily dismissing him for "gross misconduct" in allowing the senate to have his commission without the governor's knowledge or consent. Mr. Emerson contested the removal in the courts and was reinstated by the supreme court in Jan., 1924.

In addition to his regular official duties as state engineer, Mr. Emerson has served as the Wyoming commissioner on the Colorado River Commission which drafted the Colorado River Compact, and Wyoming representative upon the Board of Review upon the North Platte co-operative investigations.

The present engineering license law of Wyoming, which was enacted by the last session of the state legislature, was in many respects framed by Mr. Emerson. He is a member of the American Society of Civil Engineers.

Water-Works Convention in Chicago, June 6 to 11

The executive committee of the American Water Works Association has decided that the next convention of the association will be held at the Hotel Sherman, Chicago, June 6 to 11, 1927. Beekman C. Little is secretary and W. M. Niesley his assistant, 170 Broadway, New York City.

Sperry, Maker of Gyro-Stabilizer, Awarded John Fritz Medal

On Oct. 15 the John Fritz Gold Medal for 1927 was awarded to Elmer Ambrose Sperry, of New York, for the development of the gyro-compass and the application of the gyroscope to the stabilization of ships and aeroplanes. This annual award was made unanimously by the board of sixteen representatives of the American societies of civil, mining and metallurgical, mechanical and electrical engineers, having an aggregate membership of 56,000.

This medal is awarded not oftener than once a year for notable scientific or industrial achievement, without restriction on account of nationality or sex. It is a memorial to John Fritz, late of Bethlehem, Pa., long a leader in the American iron and steel industry. This is the twenty-third award; the first was to John Fritz in 1902 in celebration of his eightieth birthday. A few of the other medalists are Lord Kelvin, George Westinghouse, Alexander Graham Bell, Charles T. Porter, Alfred Noble, James Douglas and Henry M. Howe.

The presentation of the medal will take place on Dec. 7, in the Engineering Societies auditorium, 29 West 39th St., New York, in connection with the annual meeting of the American Society of Mechanical Engineers. At this session President William L. Abbott, of the society, will deliver the annual address and Charles M. Schwab, president-elect, will be inaugurated.

Coolidge Dam Bids to Be Received Until Nov. 10

Bids for the construction of the Coolidge Dam on the San Carlos irrigation project in Arizona will be received until 2 p.m., Nov. 10, Pacific time, at the district office of the Indian Irrigation Service, 311 Federal Building, Los Angeles, California. After the bids have been examined they will be forwarded to the Washington headquarters of the Indian Bureau where the most satisfactory bid will be accepted and a contract for the construction of the dam will be let to the successful bidder, according to the Interior Department.

The principal items involved in the Coolidge Dam are: excavation, about 26,000 cu.yd. of earth, sand and gravel; 14,000 cu.yd. of rock excavation in river bed; 195,000 cu.yd. of excavation stripping canyon's sides and spillway excavation; 187,000 cu.yd. of concrete; together with the placing of approximately 4,500,000 lb. of reinforcing steel; 1,400,000 lb. of structural steel, and 900,000 lb. of cast-iron gates and valves.

The Coolidge Dam is the principal irrigation structure on the San Carlos project. That project will embrace approximately 100,000 acres of irrigable land in the Florence-Casa Grande Valley in Arizona.

The construction of the dam was authorized by Congress at a cost not exceeding $5,500,000.

Insufficient Chlorination Causes Typhoid Epidemic in Akron, N. Y.

Insufficient chlorination of a polluted water supply and a temporary breakdown of the chlorinating apparatus is held responsible for a typhoid fever epidemic which is ravaging the village of Akron, Erie County, New York. More than two hundred persons, out of a population of two thousand, are ill with the disease, according to a press release of the N. Y. State Department of Health.

Dr. Matthias Nicoll, Jr., state health commissioner, has assigned Dr. R. D. Champlin and Dr. A. S. Dean, district state health officers, and ten health department nurses to assist in caring for the sick. Ten nurses sent by the Erie County chapter of the Red Cross and about fifty private nurses are also on duty.

In the past Akron has had occasional cases of typhoid. In 1920, following an inspection by a sanitary engineer from the state health department, the village authorities were advised to seek a new and safer water supply and, until it could be secured, to chlorinate the water, making frequent chemical tests to insure the use of sufficient chlorine. At that time the local Chamber of Commerce was attempting to initiate a movement for a new supply. Chlorinating apparatus was installed but the village continued to use the polluted water supply. The state department of heath, under the law, can not compel a municipality to abandon a water supply believed to be dangerous, the responsibility resting upon local officials and consumers.

Early in September Dr. Edward Clark of Buffalo, district state health officer, called to see several cases which proved to be typhoid fever, learned that chlorination of the water supply had been discontinued for several days during August, when the chlorinating apparatus was out of order. Tests made by a state health department engineer showed that insufficient chlorine was being applied. Apparently most of the infections, other than those resulting from contact, occurred at that time.

This epidemic, according to state health officials, is the most serious typhoid outbreak which has occurred in any similar area in the state within recent years. It offers a striking illustration, they say, of the danger of drinking polluted water, depending for safety upon chemical treatment of the supply only.

Chief Sanitation Officials Will Meet Next in St. Louis

The next annual meeting of the International Association of Street Sanitation Officials will be held at the Statler Hotel, St. Louis, Mo., Jan. 10 and 11, 1927, according to official notice just sent out by Theodore Eichhorn, superintendent, Department of Streets and Public Improvements, of Erie, Pa., who is president of the association. The secretary of the association is A. M. Anderson, 10 S. La Salle St., Chicago, Ill.

WASHINGTON NOTES

ALLEGED marring of scenic beauty has been employed so successfully in delaying waterpower development that it is becoming the standard specific used by the opponents of such projects.

The latest instance in which beauty has been dragged in by the heels is in connection with the application by the Wisconsin Power and Light Co. for rights on the Wolf River. The proposed reservoir encroaches upon a few acres of the Menonomee Indian reservation. Representations now are being made that this constitutes one of nature's garden spots.

Protests against the project of the Cumberland Hydroelectric Co., at Cumberland Falls, continue to reach Washington. Suggestions that conditions be put in the license that the power company repair the ravages of nature and rebuild the crest so as to secure the maximum of scenic effect, and that a sufficient volume of water be released to maintain the falls in full grandeur during daylight hours and on moonlight nights, do not satisfy the beauty cranks. They seem to give no weight to the fact that the reservoir above would make the falls a year-around object of beauty, whereas at present the scenic effect is lost completely during the low water season.

NEW York State's motion to file a bill joining Michigan and other States in a suit against Illinois and the Chicago Sanitary District to prohibit diversion of water from Lake Michigan into the drainage canal at Chicago was granted by the U. S. Supreme Court Oct. 11. At the same time, the Court refused a motion by Michigan for permission to amend its bill of complaint.

NO study of the effect of allowing railroads to operate ship lines on the Great Lakes and the barge canal will be made by the board of Army engineers, of which General Herbert Deakyne is chairman. The board is preparing a report for the committee on Rivers and Harbors of the House of Representatives on the cost of a 30-ft. waterway from the Great Lakes to the Hudson river. In that connection certain traffic studies are being made and estimates prepared of the savings in transportation costs which the waterway would permit. It has been suggested that the board should comment on the situation which would result were the divorce clause of the Panama Canal act amended so as to allow the railroads again to operate carriers on the Lakes and on the outlet to the Hudson river. It is contended that the railroads could use the canal to great advantage, particularly in reducing their peaks. The board, however, feels that such a study does not come within its jurisdiction.

The review of its previous findings has progressed far enough to indicate that there will be no material change in the estimates originally submitted.

Fraser Brace, Ltd., to Build South American Tunnel

Announcement is made that Fraser Brace, Limited, of Montreal, has signed a contract with the Junta Directiva de Ferrocarril de Antioquia for the construction of a railroad tunnel two miles long through the pass known as La Quiebra, in the Department of Antioquia, Republic of Colombia, South America.

The tunnel works will be designed and carried out by the engineering and construction staff of Fraser Brace, Limited, under the immediate direction of Dr. Herman Uribe, chief engineer of the railroad which runs between Medellin and the Magalena River. This railroad is interrupted at one point by a high mountain pass known as La Quiebra. The project of connecting the two portions of the railroad by means of the tunnel has been discussed for a number of years.

Engineers and foreman in the employ of Fraser Brace, Limited, are now leaving in small parties to organize and carry out the tunnel work.

Waste Elimination Is Theme of Management Week

During "Management Week," which starts on Monday, Oct. 25, more than 300 meetings will be held in 125 cities in the United States. The general subject for this year's discussion is "Progress in Waste Elimination," and it is planned to have a general audit of the accomplishments and results of the last five years' work by various agencies engaged in waste elimination work. During that period a great deal has been done by organizations acting more or less independently of one another. It is important to discover where duplication of effort is taking place and where closer co-ordination can be brought about. That the repeated emphasis laid by industrial leaders, engineers and experts in management on the potential value of waste elimination has had salutary effect is shown by the fact that, beginning with 108 meetings in 80 industrial centers in 1924, with a total attendance of approximately 15,000, the movement has grown to a point where this year each of these figures will have more than doubled.

Non-Political Board Proposed for New York State Canal

A plan to establish a board for control of the New York State Barge Canal, similar in organization to the Board of Regents of the department of education, may be placed before the 1927 legislature. The intent of such legislation is to remove the canal bureau from political influence.

The proposed legislation is said to be supported by the Canal Operators' Association, and insurance underwriters, who hold coverage on canal risks. Insurance was cancelled last year when the legislature dropped an item of $150,000 for removing sand slides at Sylvan Beach. The appropriation was replaced later.

Highway Safety Conference Held in Washington

The joint meeting of the committees authorized by the second National Conference on Street and Highway Safety to carry out the plans adopted by that conference which met in Washington last March, was held on Oct. 15, in Washington. The meeting was called by Secretary Hoover, chairman of the conference, for the purpose of surveying the activities organized in the various states to promote and adopt the conclusions and recommendations of the second conference.

In opening the meeting Secretary Hoover pointed out that, in spite of the efforts of the conference, the number of accidents occurring in this country has showed no decrease, but, on the contrary, has increased steadily. He stressed the need for continued efforts and activities of the conference members and announced that the first step of the activities, which was one of education, should be followed by state legislations to bring about uniform adoption and execution of the safety projects sponsored by the conference.

Following a general discussion various committees in attendance at the meeting engaged in separate discussions of the matters assigned for their consideration. The ten committees conferring were as follows:

Causes of accidents, design, construction and maintenance of motor vehicles, education in schools, elimination and protection of grade crossings, enforcement, public instructions and drivers' manuals, public relations, street and highway traffic facilities, traffic accident statistics and traffic laws and regulations.

The American Engineering Council signified its intention to undertake an extensive survey of street and highway facilities in accordance with the plans and aims of the conference.

St. Lawrence Power Hearing Postponed to Oct. 25

In order to give the two applicants for a license to develop St. Lawrence River water power an opportunity to present a picture of the proposed financial plan to complete the project, if a license be granted either applicant, the hearing of the New York State Water Power Commission was adjourned Oct. 15 until Monday, Oct. 25.

Frontier Corporation offered in evidence a map showing a complete system of interlocking transmission lines covering practically the entire state of New York outside of New York City and Long Island and stated that it had tentative agreements with the electrical corporations owning such interlocking systems to take and distribute the current when generated.

Edward C. Randall, president of the American Super Power Corporation testified that his company proposed to build one transmission line to the borders of the city of New York and that the New York Edison Co. with five associate companies would be the beneficiary of such current to the extent of their peak load of 600,000 hp.

Engineering Societies

Calendar

Annual Meetings

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, Washington, D. C.; Annual Convention, Pinehurst, N. C., Nov. 8-12, 1926.

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, St. Louis, Mo.; Annual Meeting, Washington, D. C., Nov. 8-12, 1926.

FIFTH ANNUAL ASPHALT PAVING CONFERENCE, AUSPICES ASPHALT ASSOCIATION, New York City, Washington, D. C., Nov. 8-12, 1926.

NATIONAL COUNCIL OF STATE BOARDS OF ENGINEERING EXAMINERS, Columbia, S. C.; Annual Convention, Philadelphia, Pa., Nov. 15-16, 1926.

HIGHWAY RESEARCH BOARD, OF NATIONAL RESEARCH COUNCIL, Washington, D. C.; Annual Meeting, Washington, D. C., Dec. 2 and 3, 1926.

AMERICAN ROAD BUILDERS ASSOCIATION, New York City; Annual Convention and Road Show, Chicago, Ill., Jan. 10-14, 1927.

The Montreal Branch of the Engineering Institute of Canada met Oct. 14 and the speaker was Dr. H. T. Barnes, his subject being Engineering Features in Breaking the Allegheny Ice Gorge. Major G. A. Walkem, the Institutes' president, was another speaker.

New York State Section of the American Water Works Association will have a luncheon meeting Oct. 23 at the Onondaga Hotel, Syracuse. M. B. Palmer, engineer of the Syracuse Bureau of Water, will give a brief description of that city's water-works; and Nicholas S. Hill, Jr., of New York City, will tell about the new water supply for the city of Tampa, Florida. After the luncheon there will be a trip to the Syracuse reservoir.

The National Association of Railroad and Utilities Commissioners will hold its annual convention at Asheville, N. C., Nov. 9-12. William A. Prendergast, chairman of the New York Public Service Commission and of the Association's Public Utility Rates Committee, will deliver the principal address. Other speakers will be John J. Esch of the Interstate Commerce Commission; M. H. Aylesworth, former chairman of the Colorado Public Utilities Commission; John A. Small, president of the National Rivers and Harbors Congress; C. C. McChord, former chairman of the Interstate Commerce Commission; Edward W. Bemis, public utility expert of Chicago, and H. A. McKeown, K.C., chief commissioner of the Board of Railway Commissioners for Canada. Regulation of interstate motor vehicle carriers will be one of the chief topics of discussion.

The Colorado Society of Engineers at its Oct. 8 meeting were informed of the purposes of the "pay-as-you-go" highway finance plan, by Oliver T. Reedy, senior assistant highway engineer. Lyman Bishop spoke on "Flood Control."

Personal Notes

PROF. J. B. MARCELLUS, associate professor of civil engineering at the University of Colorado, has resigned to become private engineer to and to develop an extensive estate for E. W. Marland, president of the Marland Oil Co. The estate, at Ponca City, Okla., includes a city subdivision, for which the engineering work will include paving, water lines and other features. Professor Marcellus had been at Colorado for the past seven years.

FRANK F. HEALEY, civil engineer, Chicago, has been engaged by the State Bank of Chicago as manager of the engineering department in charge of appraisals and construction. Mr. Healey has had a long line of experience in estimating and contracting as well as engineering of heavy construction including New York subways, aqueduct and tunnels, office building and manufacturing plants. During the war he was in charge of all field work at Newport News, Va., building five camps.

W. A. FRENCH, formerly county engineer of San Augustine and Sabine counties, Texas, is now associated with Charles D. Evans, consulting engineer, 414 Levy Building, Shreveport, La., as assistant and office engineer.

CHESTER C. OBERLEAS, of Sheridan, Ind., has been appointed city engineer of Indianapolis to succeed GEORGE G. SCHMIDT. Mr. Oberleas, who is county surveyor of Hamilton County, and a candidate for re-election, will assume his new duties immediately. Mr. Oberleas, who is 33 years old, was graduated from Purdue University eleven years ago. He will submit his resignation as county surveyor and retire from the county Republican ticket.

S. FRAPPIER of Montreal, Quebec, has been appointed Director of Public Works and chief architect for Quebec Province, suceeding the late George St. Michel.

Obituary

WASHINGTON JENKINS, civil engineer, Ogden, Utah, died at his home in that city Oct. 10, aged 69 years. Mr. Jenkins served for many years as city engineer of Ogden and county surveyor, and supervised many of the important projects of the city.

ARTHUR HOLLAND, identified for many years with the iron and steel trade in Pittsburgh and with railway interests, died Oct. 2 at his home in Concord, Mass. Mr. Holland became president of the United Railways of San Francisco in 1901. In 1907 he reorganized the street railways of York, Pa. For a short time after that he was president of the Bangor & Aroostook R.R.

HERBERT E. SMITH, assistant engineer of the Board of Water Supply, Gas and Electricity, New York City, died Oct. 13, aged 55 years.

Construction Equipment and Materials

A SECTION DEVOTED TO WHAT THE MANUFACTURER IS DOING FOR THE ENGINEER AND CONTRACTOR

All-Western Road Show Held at San Francisco

Exhibitors Number 205 and Space Under Canvas Approximates 250,000 Sq.Ft.

The second All-Western Road Show held at San Francisco Oct. 7-15 had on display a considerably larger number of exhibits and drew a larger attendance than did the first Road Show held in November last year. Space in the five circus tents used this year was all taken well in advance of the opening date and the show began on schedule time with 205 exhibitors and about 250,000 sq.ft. of space under canvas. The show as a whole occupied about 20 acres on the Marina near the grounds used in 1915 by the Panama Pacific International Exposition.

Besides the tent space there were extensive areas on two sides of the show grounds where 34 firms gave actual demonstrations of a wide variety of equipment such as power shovels, scrapers, ditchers, post-hole diggers, drag lines, tractors, etc. The value of equipment on display this year was estimated at $3,000,000. An account of the previous All-Western Road Show was published in *Engineering News-Record*, Nov. 19, 1925, p. 856.

A record attendance of 10,000 on Sunday, Oct. 10, showed the extent of public interest in this year's show although the numbers that visited the show on that date were probably increased by the front-page newspaper publicity resulting from the collapse of two of the tents in a heavy windstorm on Saturday. The damege was quickly repaired and good weather obtained throughout the remainder of the show.

Improvements Over Last Year

Several changes were made in the arrangement and program this year as the result of experience with the first show. For example, instead of a single main street with entrances at one end of the tents only, four of the main tents were this year grouped around the fifth main tent and other attractions located in the center. Thus visitors could pass directly from one tent into another or into the central enclosure and could see all of the exhibits with a minimum of walking. Within the enclosure were the convention tent and smaller shelters for information bureaus, telephones, restaurant, etc.

A record of the attendance this year was made possible by requiring all who entered the grounds to register. Although no admission fee was charged uniformed police were stationed at all entrances and no one was admitted without registration, a sufficient number of clerks being kept on duty to record registration and issue badges. This year the show was open from 9 a.m. to 5 p.m. daily, no evening sessions being held.

Instead of the daily paper issued at the first show a uniformed page was this year stationed on a centrally located, elevated platform in each tent where he received by telephone announcements to be made from time to time or paged individuals wanted on the phone. A total of 25 phone connections were in use on the show grounds.

More attention was given this year to educational features; by special invitation groups of students from the two leading universities in the Bay region were conducted about the show by guides and endeavor was made to interest and inform the public in problems concerning the contractor and construction generally, particularly in road-building. Fewer conventions were held in connection with the show this year, the three principal meetings being the annual convention of the Western Association of State Highway Officials; the convention of the Western Construction Equipment Distributors; and the Western State County Officials Association. Evening features of the Show, not held on the show grounds, were the Road Builders' smoker with boxing, wrestling and vaudeville attractions on Saturday, Oct. 9, and a dinner dance on Tuesday, Oct. 12.

Concrete Road Yardage

For September the square yardage included in concrete pavement contract awards, according to the Portland Cement Association, were: 3,736,005 for roads; 4,342,265 for streets; and 299,350 for alleys; or a total for the month of 8,377,620 sq.yd.

The accompanying table summarizes the statistics for the current year:

SQUARE YARDS OF CONCRETE PAVEMENT AWARDED DURING 1926

Month	Roads	Streets	Alleys	Total All Classes
Jan.....	2,161,415	1,410,201	57,218	3,628,834
Feb.....	2,726,611	2,010,941	274,836	5,012,388
March..	4,662,885	3,050,630	224,879	7,938,394
April....	8,758,195	4,324,729	479,763	13,562,687
May....	8,910,678	4,619,195	507,250	14,037,123
June....	10,793,452	5,999,859	524,572	17,317,883
July....	5,662,841	4,865,421	327,313	10,855,575
Aug....	6,594,150	6,293,849	360,991	13,248,990
Sept....	3,736,005	4,342,265	299,350	8,377,620
Totals	54,006,232	36,917,090	3,056,172	93,979,494

Business Notes

Silent Hoist Winch & Crane Co. announces a change of address of its factory and general offices into its new building at 762-772 Henry St., Brooklyn, N. Y.

George E. Tyson, for the past 12 years in the production department of the Reading Iron Co., has been appointed representative in the Reading territory which includes central New York and eastern Pennsylvania, excluding Philadelphia. Mr. Tyson's headquarters are in the general offices of the company at Reading, Pa.

Waukesha Motor Co., Waukesha, Wis., has just declared a $1,000,000 stock dividend said to be the result of the largest and most successful year's business that the company has ever had. The retirement of all the outstanding preferred stock of the company was accomplished before dividends were paid. It is said that a reorganization is under way for the purpose of listing the stock on some national exchange. No change is contemplated in the directorate.

Westinghouse Electric & Mfg. Co., Each Pittsburgh, Pa., announces the reorganization of its engineering department at its South Philadelphia works. W. B. Flanders, formerly engineer, large turbine division, has been appointed assistant manager of engineering; R. C. Allen, formerly assistant to chief engineer, has been appointed manager large turbine engineering; J. A. MacMurchy, formerly engineer, small turbine division, has been appointed manager small turbine engineering; and D. W. R. Morgan, formerly engineer, condenser division, has been appointed manager condenser and internal combustion engineering.

John M. Seyfert, the last surviving son in the firm of L. F. Seyfert's Sons, Inc., Philadelphia, manufacturers of engines, boilers, pumps and general machinery, died in his home in Philadelphia Sept. 28, 1926. His family was long identified with the iron industry of Pennsylvania both before and after the Civil War. Simon Seyfert, the grandfather, was the founder of the Reading Iron Works, Reading, Pa.

New Developments

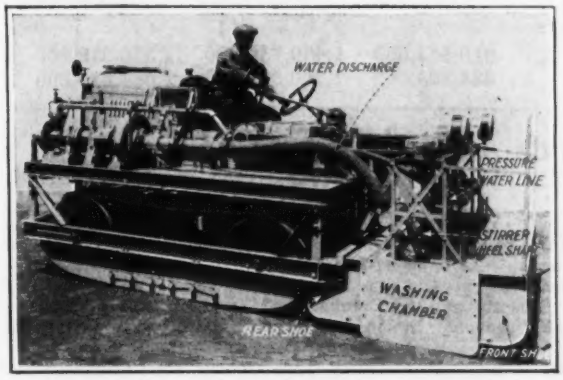
Tractors Clean Slow Sand-Filters in Philadelphia

Tractor filter-sand washers have been under test at the Belmont slow sand-filters at Philadelphia for several years. The first machine was an experiment and on the basis of its performances many improvements have been made on it; in fact, its performance records have resulted in the installation by the city of Philadelphia of several batteries of these machines at its large filter plants. Two of these tractor washers are in use at the Belmont plant where there are eighteen ¾-acre filters. Three washers are in use at the Torresdale filter plant which consists of sixty-five ¾-acre units and another washer is in use at Roxborough filter plant where there are eight ¾-acre units. Two machines wash a ¾-acre bed in from 9 to 10 hours, the normal speed of the tractor being 10 ft. per min. The tractor is said to be capable of washing 33, 66, or 99 sq.ft. per min. of filter surface to a

depth of 12 in., depending on the travel speed. This purchase by the city of Philadelphia represents the first installation of these machines.

The tractor consists of a structural steel chassis upon which is mounted a gasoline engine, a driving mechanism and a washing unit. On each side of the chassis is a belt tread driven by sprockets and chains. The washing unit is made up of a washing chamber, formed by the floats or air-chambers shown in the illustration as the front and rear shoes and six stirrer-wheels carrying teeth through which water is injected into the sand. The stirrer-wheels are attached to the bottom end of the shaft shown in the illustration. One drive-shaft connected to the engine transmits power to the six stirrer-wheels. The washing unit is pivoted to two radius arms which raise and lower it and by means of which the unit always follows the contour of the filter. The washing unit has practically no weight when submerged.

Two centrifugal pumps connected by



a single drive-shaft are operated by the engine. They supply the water for the teeth and also lift the dirty water from the washing chamber discharging it into a 3-in. hose which conveys it outside the filter. The washing chamber is 80 in. wide. The total quantity of dirty water discharged is approximately 225 g.p.m., 40 gal. of which represent water supplied by the force pump to the teeth.

The weight of the machine is about 8,800 lb., or about 2 lb. per sq.in. on the sand, taking into consideration the buoyant effect of the water in which the machine operates. The belts are 27 in. wide, and the c. to c. distance of the driving-wheels is 60 in. Normally the machine operates with the washing unit ahead. The washing crew consists of a driver and helper.

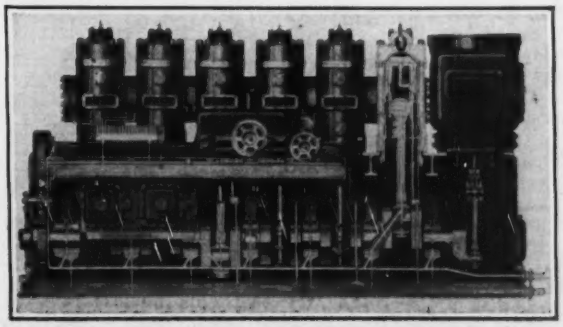
When cleaning, the filter is first drained to within 2 ft. of the sand and then shut off. The washing unit operates as follows: As the chamber slides on the muddy surface of the sand the pump forces water down the stirrer-shafts through the hollow teeth and out into the sand. At the same time that the stirrer-wheels are revolved in the sand, suction is applied to the top of the chamber, drawing the water and the sand. The mud in the sand is dissolved and the sand lifted into suspension by the agitation and upward movement of the water in the chamber. The muddy, sandy water is drawn upward through the washing chamber and the sand is dropped by the slowing down of the agitation in the upper section of the chamber. Agitation and suction are combined to scour the sand free from the mud and the bacteria. The tractor is manufactured by M. L. Bayard & Co., Philadelphia, for the Blaisdell Filtration Co.

Diesels of Airless Injection Type Made in Larger Sizes

Diesel engines in ratings of 480, 600 and 720 hp. have been developed and are now made available by Fairbanks, Morse & Co., Chicago. The company has found that there has developed a greater demand for larger engines and these new ratings have been brought out as a result of this demand. These larger Diesels are of the two-cycle, single-acting, port scavenging, airless injection type. With these fundamental principles as used on the company's smaller engine, a number of other features have been incorporated including two-stage combustion, a pressure lubricating system, centralized control and a built-in scavenging pump.

The two-stage combustion principle which is also used on the smaller engines causes the fuel to be first burned to carbon monoxide and later with the entrance of more air to effect final combustion to carbon dioxide. This is said to result in complete burning of the fuel unaccompanied by any pressure rise.

Complete control of the engine is centered in a compact unit located at the center of the engine and housing the injection pumps and air-starting mechanism. A governor unit is mounted alongside the injection and air starting unit thus centralizing the complete control system. The larger handwheel is used in starting the engine. Speed control is taken care of by the smaller handwheel which changes the setting of the governor spring.



All the main bearings, piston pins and gears are lubricated under pressure. A rotary oil pump forces the oil into a header under pressure from where it is distributed by branch lines to all the main bearings. Each of the cylinders is lubricated at three points by a forced-feed lubricator. The unique feature of the cylinder lubrication is the use of four wiping rings placed in a recess at the lower part of each cylinder. The upper and lower edge of each ring makes a wiping contact with the piston, the oil which is wiped off being drained to a small pocket in the ring itself. A small pipe header takes this oil to a sump and from the sump it passes through a purification system. There is thus no loss of oil through the exhaust ports due to the oil working up past the piston. Purifying the oil before it is again used for cylinder lubricant is also an advantage. This lubricating and piston-cooling system also does away with the necessity of any stuffing boxes.

Glass Coverings for Sludge Beds Available in Standard Units

Covering sludge drying beds with a glass superstructure of the greenhouse type dates back to 1912 at the Cleveland, Ohio, sewage testing station. Since then a number of installations have been made in different municipal-

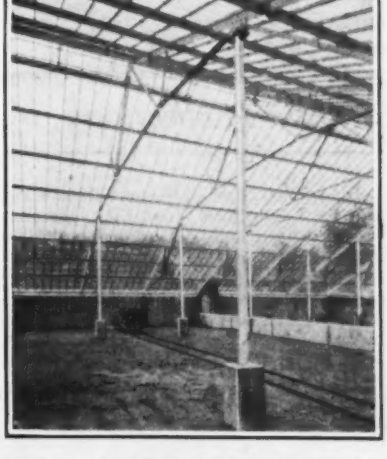


FIG. 1—COVERED SLUDGE BED AT BOONTON, N. J.

ities and the Lord & Burnham Co., Irvington, N. Y., has now developed a glass-over unit for this use made of standardized sections. This company, which has a number of factories in the central and eastern United States and Canada, has for many years been building greenhouses and similar inclosures of glass.

This sludge bed covering is of somewhat heavier construction than that ordinarily used for greenhouses. The

framework is of steel, while the part of the columns that extends into the concrete footings is of wrought iron. At the eaves and other locations where condensation may cause corrosion, the metal members are galvanized. All wood used in the construction is of cypress of the grade used for water storage tanks.

There are three main advantages

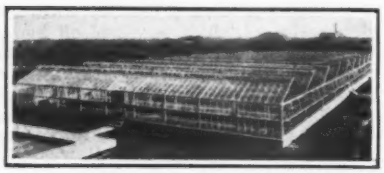


FIG. 2—COVERED SLUDGE BEDS AT MARION, OHIO

claimed for the glass-over construction for sludge drying beds: (1) The area required for covered beds is one-third or less of that required for open beds; (2) sludge beds covered with glass have a much more attractive appearance than do the usual open types; and (3) probably the greatest advantage lies in the fact that the efficient operation of a covered bed is relatively independent of weather conditions. Better results are obtained not only in the colder months but during the summer, when wet weather ordinarily slows up the length of the time that the sludge must lie on the beds.

New Publications

Pipe Protection — WAILES-DOVE-HERMISTON CORP., New York City, has just issued a 44-p. publication entitled "The Protection of Pipe Lines," which gives something of the history of the protection of steel and cast-iron pipe and describes the use and results obtained by applying the company's bituminous compounds known as "Bitumastic Enamel" and "Hermastic Pipe Coating." A number of the company's applications on important pipe lines are illustrated and described in the book. Descriptions are given of the method employed for the protection of cast-iron and steel pipe and special attention is given to oil and gas mains.

Truck Bodies for Concrete—EASTON CAR & CONSTRUCTION CO., Easton, Pa., has issued Bulletin 303 devoted to its concrete batch truck body for use on Ford trucks. The bodies are of steel and of the rollover type. Trailers of the same design are also described.

Spray Painting — DUNN PAINTING MACHINE CO., 835 Howard St., San Francisco, Calif., has made available two pamphlets describing its paint spraying equipment. Drawings are given of the details of the apparatus as well as other illustrations and text describing the machines. A list of the number of the users of these painting machines is given.

Business Side of Construction

FACTS AND EVENTS THAT AFFECT COST AND VOLUME

This Week's Contracts—Week Ago—Same Week Last Year

THE money value of contracts reported in the present issue of *Engineering News-Record* is here compared with the figures for corresponding weeks. Minimum costs observed are: $15,000 for water-works and excavations; $25,000 for other public works; $40,000 for industrial and $150,000 for commercial, educational, religious and other buildings.

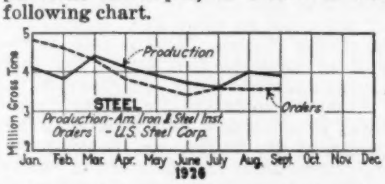
Money Value of Contracts Let—Entire U. S.

Week Ending	Public Work	Private Work	Total Contracts
Oct. 21, 1926	$21,791,000	$41,944,000	$63,735,000
Oct. 14, 1926	13,598,000	19,985,000	33,583,000
Oct. 22, 1925	21,468,000	31,088,000	52,556,000
Heaviest Week			
1926, Mar. 11	13,029,000	73,613,000	86,642,000
1925, Sept. 3	16,215,000	69,424,000	85,639,000
January 1 to date			
1926	910,562,000	1,439,756,000	2,350,318,000
1925	884,303,000	1,200,376,000	2,084,679,000

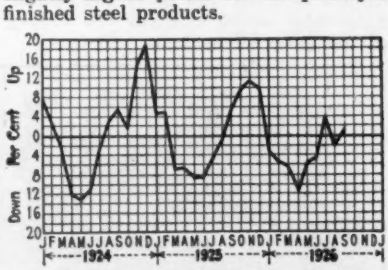
Price Trends As Indicated By Production and Demand

MOVEMENTS of current supply and demand in four basic building materials, indicate an upward tendency in steel, steadiness at present levels in lumber and cement, and a slight weakening, probably seasonal, in common brick.

A gain of 1.4 per cent in September steel demand was met by a drop of 1.7 per cent in output, as shown in the following chart.



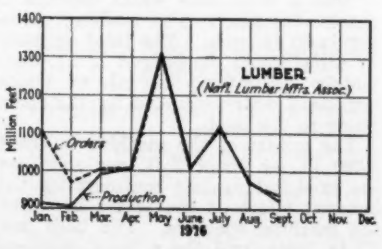
The existing method of buying for immediate requirements only, tends to eliminate heavy reserve stocks. The present situation, therefore, favors slightly higher prices for the principal finished steel products.



UNIFORMITY OF DEMAND AS SHOWN BY MONTHLY MOVES OF STEEL ORDERS

The per cent gain or loss in steel tonnage booked each month by the U. S. Steel Corporation, from January, 1924 to the end of September, 1926, shows a uniformity of demand broken only on two occasions. The instances referred to were the unusually small gain of October, 1924 and an abnormal spurt in demand which occurred in July, 1926. Judging from these records of the last thirty-three months, steel orders should continue to gain during the rest of the current year.

Lumber production, generally, has been kept very close to orders since April of the current year, as shown by the following chart.



Despite this fact, reports of overproduction in fir timbers filter in from the Pacific Northwest. Pine and hardwoods, however, are being stocked in quantities slightly below normal for this time of the year, with the result that danger of price weakness is greater in fir than in the other species.

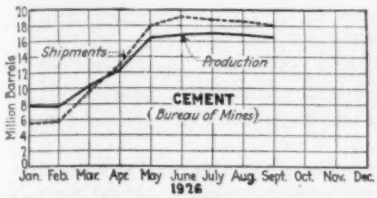
Since early summer, cement production and shipments on orders, have run parallel. A seasonal drop of 9.5 per cent in September reserve mill stocks, as compared with the month preceding, helps to stabilize cement prices at present levels, especially since the volume of proposed construction justi-

(*Continued on p. 687*)

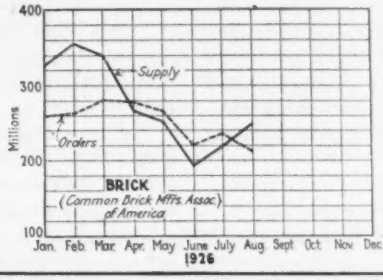
Price Trends as Indicated by Production and Demand

(*Continued from p. 686*)

fies expectations of continued heavy demand.



Brick orders are falling off, while the supply at yards throughout the country continues to pile up. At this time last year, buying was just a little ahead of the quantity of burned brick in reserve. Production normally ceases in the Northern states during the colder months of the year. Perhaps during the current quarter, brick making will slow down to a degree consistent with the volume of orders now coming through, otherwise price declines are to be expected.



Bids Submitted by Americans On $117,000,000 Cuban Project

Bids on Cuba's tremendous road program were submitted Sept. 27 by Ulen & Co., National Foundation Co., James Stewart Co. and a combine headed by the National City Bank of New York. This combine, consisting of Warren Bros. Co., George A. Fuller Co., Dwight P. Robinson, Lock Joint Pipe Co., and Mellon-Stuart Co., submitted a comprehensive bid and financial plan which will allow all of the most important public work to be done in a period of 4 years and will embrace the Central Highway, school buildings, public buildings, sewers, aqueduct and a great deal of public work to be done in the City of Havana comprising a total of $117,000,000.

September State and Municipal Bond Sales Reach Record For That Month

STATE and municipal bond flotations in September reached the figure of $129,863,392 and according to *The Commercial and Financial Chronicle* is the highest September on record. The total for the nine months of this year has passed the billion dollar mark but is not as large as the corresponding periods of the two previous years.

The State of New York made the largest offering of the month, selling five issues of 4 per cent bonds, aggregating $28,475,000. The next largest disposals were as follows: seven issues of 4½s aggregating $10,000,000 by Allegheny Co., Pa.; two issues of 4s and 4½s aggregating $8,500,000 by St. Louis; $7,500,000 of 4½s by the State of Missouri. Sales for the first nine months of 1926 totaled $1,003,264,494.

The following table compares the various forms of securities placed in September from 1922 to 1926:

	1926	1925	1924	1923	1922
Permanent loans (U. S.)	$129,863,392	$115,290,336	$124,336,682	$56,398,075	$99,776,656
Temporary loans (U. S.)	53,613,000	62,603,902	63,795,847	40,141,600	48,441,000
Canadian loans (permanent)					
Placed in Canada	3,224,752	87,438,534	95,323,898	58,321,196	5,365,320
Placed in U. S.	None	None	90,698,203	None	6,523,000
Bonds of U. S. possessions	None	None	None	610,000	5,142,000
General fund bonds (N. Y. C.)	3,300,000	4,200,000	None	1,000,000	2,000,000
Total	$190,001,144	$269,532,772	$374,157,630	$156,470,871	$167,247,976

Representative Public Bond Sales, September, 1926

State	Purpose	Amount	Rate Per Cent	Sold For	Basis	Dated	Maturity	Purchased by
Alabama	Road, bridge and highway	$3,000,000	4½	100.75	4.39	June 1	1927-60	Ward, Stern & Co., and others, of Birmingham
Maine	Highway and bridge	$600,000	4	100	4	Sept. 15	1927-41	Estabrook & Co. of Boston
Missouri	Road	7,500,000	4½	100.608	4.19	Sept. 1	1943-46	Speyer & Co. of New York City
New Mexico	Highway	350,000	5	100.172	4.87	Sept. 1	1927-28	Sidlo, Simons, Day & Co. of Denver
New York	Grade crossing elimination	10,000,000	4	101.9289	3.86	Sept 1	1927-76	Blair & Co. and others of New York
	Impvt	8,350,000						
County								
Alameda Calif	Hospital	$200,000	5	108.41	4.31	.....	1943-44	Blyth, Witler & Co. of San Francisco
Allen, Ind	Bridge	87,000	4½	100.52	4.23	Aug. 15	1927-29	Fletcher Savings & Trust Co. of Indianapolis
Blackford, Ind	Road	109,000	4½	101.62	4.79	Aug. 26	10 years	Fletcher Savings & Trust Co. of Indianapolis
Camden, N. J	Impvt	290,000	4½	100.07	4.24	Sept. 1	1928-43	Prendergast & Co. and others of New York
Chautauqua, N. Y	Highway	250,000	5	105.59	4.28	April 1	1934-35	Bonbright & Co. and others of New York
Columbia, Fla	Road	500,000	6	101.102	5.92	June 1	1956	Atlantic National Bank of Jacksonville
Cuyahoga, O	Sewer	1,008,000	4½	100.64	....	.....	1927-41	Guardian Trust Co. of Cleveland
Dallas, Tex	Courthouse	75,000	5½	100	....	.....	1927-31	George L. Simpson & Co. of Dallas
Hillsborough, Fla	Highway	310,000	5½	100.31	5.19	Aug. 1	1928-36	Citizens' Bank & Trust Co. of Florida
Hunterdon, N. J	Road and jail	219,000	5	105.47	4.34	Sept. 1	1927-46	Graham, Parsons & Co. of New York
Laurens, S. C	Road	500,000	5	100.83	4.93	Oct. 1	1931-55	Braun, Bosworth & Co. of Toledo
Lincoln, W. Va	Road	432,000	5	100.60	4.92	June 1	1927-42	Seasongood & Mayer of Cincinnati
Mingo, W. Va	Road	71,000	5	100.25	4.97	May 1	1927-44	Weil, Roth & Irving Co. of Cincinnati
Monroe, Pa	Road improvement	80,000	4½	100.86	....	June 1	1931-46	Mellon National Bank of Pittsburgh
Nassau, N. Y	Highway and bridge	1,200,000	4½	100.74	4.13	July 1	1928-38	First National Bank and others of New York
Pottawatamie, Ia	Road	61,000	4½	101.10	4.32	Aug. 2	1931-36	G. M. Bechtel & Co. of Davenport
Rockland, N. Y	Highway	70,000	4½	101.13	4.27	Sept. 2	1927-36	Sherwood & Merrifield of New York
Snohomish, Wash	Road improvement	13,000	6	100	....	.....	1934	The Citizens' Bank & Trust Co. of Everett
Spencer, Ind	Road	8,800	5	104.43	4.26	Sept. 15	1928-38	Dale State Bank of Dale
Sussex, Del	Road	500,000	4½	101.109	4.42	Oct. 1	1934-53	Bankers' Trust Co. and others of New York
Yavapai, Ariz	Hospital	15,000	5	100.69	4.75	Sept. 1	1927-31	Valley Bank of Phoenix
Township								
Banks, Pa	Road improvement	11,000	4½	100	....	Oct. 1	1937	County commissioners
Pensauken, N. J	Paving	200,000	....	....	....	.....	.....	Pensauken Township National Bank
Walcott, N. D	Road improvement	20,000	5	100	....	.....	1931-46	B. Fisher of Walcott
Municipal								
Agurs, La	Waterworks	37,000	6	100.14	....	.....	1926-50	Commercial Securities Co. of Shreveport
Akron, O	Street improvement	1,236,200	5	102.02	4.56	Sept. 1	1928-36	Herrick Co. of Cleveland
Ambridge, Pa	Incinerator	45,000	4½	100.06	4.24	.....	1936-44	Ambridge Savings & Trust Co. of Ambridge
Audubon, Ia	Sewer	38,000	4½	100.26	....	July 1	.....	White-Phillips Co. of Davenport
Birmingham, Ala	Public improvement	200,000	4½	100.51	4.39	Oct. 1	1927-36	Ward Sterne & Co. of Birmingham
Blairsville, Pa	Water	90,000	4½	103.11	....	July 1	1938-56	First National Bank of Blairsville
Bowling Green, O	Paving	6,300	5	101.15	4.78	Mar. 1	1928-36	Teachers Retirement System
Canton, O	Improvement	1,249,311	5	100	....	June 1	1928-32	George D. Harter Bank of Canton
Clearwater, Fla	Improvement	410,000	6	99.14	6.07	Sept.	1956	Magnus & Co. and others of Cincinnati
Dearborn, Mich	Paving	50,850	6	100.05	5.98	Aug. 15	1927-31	Joel Stockard & Co. of Detroit
Decorah, Ia	Streets	53,600	5	.....	....	.....	1927-36	Fred Carlson Paving Co. of Decorah
Emporia, Kan	Improvement	100,000	4½	103.15	4.27	Sept 15	20 yrs.	Branch-Middlekauff Co. of Wichita
Euclid, O	Waterworks	6,000	5½	101.17	5.12	Sept. 15	1927-32	Guardian Trust Co. of Cleveland
East Flat Rock, N. C	Water	50,000	5½	100.09	5.74	Aug. 1	1929-66	Stranahan, Harris & Oatis, Inc., of Toledo
Eugene, Ore	Water extension	30,000	4½	109	4.09	Aug. 15	1956	George H. Burr, Conrad & Broom of Seattle
Eustis, Fla	City Hall	125,000	6	96.63	6.29	July 1	1936-56	First State Bank of Eustis
	Pier and Bulkhead	10,000						
Gloucester, Mass	Sewer	250,000	4	100.76	....	Sept. 1	1927-46	R. L. Day & Co. of Boston
Good Water, Ala	Waterworks	20,000	6	97.50	6.22	Sept.	1946	J. B. McCrary Engineering Corp. of Atlanta
Guttenberg, N. J	School	245,000	5½	102.04	4.76	July 1	1927-46	Lehman Bros. of New York
Hagerstown, Md	Market Building	150,000	4½	103.937	4.23	Oct. 1	1936-65	Strother, Brogden & Co. of Baltimore
	Street improvement	80,000	4½	103.337	4.24			

Weekly Construction Market

PRICE changes during the last week, in the nine great industrial districts covered by *Engineering News-Record*, were few in number, so far as printed tables go.

A downward tendency, that appears to be slightly more than a seasonal easing off in prices, is noted in the current market for Douglas fir, white oak, red cedar shingles, yellow pine flooring, lath, and No. 1 com. 1-in. boards. The decline is very marked in linseed oil, and affects, to a lesser degree, the concrete aggregates, gypsum plaster, common brick, window glass and turpentine.

Long-leaf yellow pine timbers at New York are just about $1 per M. ft. below the May, 1926, level.

Cement holds steadily in every direction. The principal heavy-rolled steel products are equally firm at the $2 per 100 lb. level for large tonnages of reinforcing bars and shapes, with $2.10, f.o.b. Pittsburgh mill, applying on single carload lots.

Plates seem unable to bring more than $1.90 per 100 lb., Pittsburgh, while many consumers have covered at this figure, in bar and shape requirements for the current quarter.

Pig iron, the controlling factor in steel prices, shows a decidedly firmer attitude this week. Actual advances are not well enough established to warrant changes in the quotations as published in *E. N.-R.* issue of Oct. 7.

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montrea
Steel Products									
Structural shapes, 100 lb	$3.34	$3.80	$4.15	$3.10	$3.35	$3.07½	$3.30	3.35	$3.75
Structural rivets, 100 lb	4.20	3.80	4.75	3.50	3.75	4.65	5.00	4.00	5.50
Reinforcing bars, ¾ in. up, 100 lb	3.24	2.80	3.38	2.25@2.40	2.87½	3.77½	2.95	3.25	2.50
Steel pipe, black, 2½ to 6 in. lap, discount	48%	54%	53.6%	51%	54.25%	41%	49.7@54.1%	45%	37.83
Cast-iron pipe, 6 in. and over, ton	51.60@52.60	45.25	54.00	48.20	53.00	64.00	50.00	55.00	55.00
Concreting Material									
Cement without bags, bbl	2.50@2.60	2.35	2.05	2.10	2.32	2.85	2.31	2.65	1.15
Gravel, ¾ in., cu.yd	1.75	1.90	2.38	1.60	1.65	1.90	1.80	1.50	1.50
Sand, cu.yd	1.00	1.60	2.00	1.40	1.25	1.00	1.40	1.50	1.25
Crushed stone, ¾ in., cu.yd	1.94	2.50	2.83	1.87½	1.75	2.50	1.70	3.00	2.00
Miscellaneous									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft	62.00	34.00	56.00	58.25	+38.75	34.75	27.00	23.00	50.00
Lime, finishing, hydrated, ton	18.20	23.50	19.00	20.00	25.50	24.00	25.50	24.00	21.00
Lime, common, lump, per bbl	2.10@3.00	1.50	1.82	1.50	1.70	2.70	1.60	2.80	10.00
Common brick, delivered, 1,000	20.40@22.40	10.50	14.10	12.00	13.75	9@10	15.00	15.00	20.25
Hollow building tile, 4x12x12, per block	Not used	.0895	.112	.088	.076	.075	.....	.09	.10
Hollow partition tile 4x12x12, per block	.1112	.0895	.112	.088	.076	.075	.108	.09	.08
Linseed oil, raw, 5 bbl. lots, per 7½-lb. gal	.85½	.99½	1.10	.88	.94½	1.08	1.01	1.12	1.05
Common Labor									
Common labor, union, hour	.90½	.30	.....	.90	.....	.50@.55	.55	.62½	.....
Common labor, non-union, hour	.....	.25	.30@.50	.82½	.45@.60	.40@.45	.50	.50	.30@.35

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given; 45-5% means a discount of 45 and 5 per cent. L.c.l. is less than carload lots.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime in 280-lb. bbl. net and hydrated lime, f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b. Reinforcing bars (billet steel) and shapes delivered to job in less-than-carload lots.

Labor — Cement and concrete laborers' rate, $1.06¼; building laborers, 90½c.

Chicago quotes hydrated lime in 50-lb. bags; common lump lime per 180-lb. net. Lumber, sand, gravel and stone f.o.b.; price on fir is quoted instead of pine. Reinforcing bars (billet steel) f.o.b. warehouse in carload lots; shapes, less-than-carload lots.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed stone quoted at pit. Bars (billet steel) at warehouse in carload lots; shapes, less-than-carload lots.

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of Oct. 7 the next on Nov. 4.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered in wooden bbl. Common lump lime per 180-lb. net. Bars (billet steel) and shapes, l.c.l.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net. Bars (billet steel) f.o.b. in carload lots; shapes, l.c.l.

Dallas quotes lime per 180-lb. bbl. Cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered. Bars (billet steel) and shapes, l.c.l.

San Francisco quotes on Heath tile, size 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C.-I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir, common. Bars (billet steel) f.o.b. in carload lots; shapes, l.c.l.

Seattle quotes on Douglas fir (delivered) instead of pine. Lump finishing lime per 180-lb. net. Brick and hollow building tile delivered. Hydrated lime in paper sacks. Sand and gravel at bunkers. Bars (billet steel) and shapes, less-than-carload lots.

Montreal quotes on fir lumber. Sand, stone, gravel and lump lime per ton. Stone and tile are delivered; sand, gravel, lime and cement on siding; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at 100.093). Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 2½ in., $37.83. Bars (billet steel) carload lots; shapes, l.c.l.

Business Briefs

Call money quoted at 4½ per cent, Oct. 18; year ago, 4½ per cent.

Time loans: Sixty days to six months, 5 per cent.

Commercial paper: Best names, 4@6 mo., 4½; others, 4¾ per cent.

On Oct. 1, 1926

E. N.-R. Construction Cost Index Number 209.80

E. N.-R. Construction Volume Index Number 227

For Explanation and Details of Indexes Since 1913 See the First Issue of Every Month